FAA-E-2711 A

SEPTEMBER 26, 1983

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SPECIFICATION

FLIGHT DATA INPUT/OUTPUT

CONTENTS

1. SCOPE

1.1 SCOPE - This specification sets forth the requirements for the Flight Data Input and Output (FDIO) Replacement System, which shall replace existing Flight Data Entry and Printout (FDEP) and enroute Flight Strip Printer (FSP) systems.

1.2 ABBREVIATIONS AND DEFINITIONS - Sections 1.2.1 and 1.2.2 detail the definitions of frequently used abbreviations and terms used in this specification.

1.2.1 ABBREVIATIONS

AC	- Alternating Current
ADCCP	- Advanced Data Communications Control Procedures
ARTCC	- Air Route Traffic Control Center
ATCT	- Air Traffic Control Tower
CCU	- Central Control Unit
CCC	- Central Computer Complex
CPU	- Central Processing Unit
CRT	- Cathode Ray Tube (display)
DC	- Direct Current
DCCU	- Data Communications Control Unit (existing FDEP)
DOT	- Department of Transportation
FAA	- Federal Aviation Administration
FDIO	- Flight Data Input/Output
FDEP	- Flight Data Entry and Printout
FSP	- Flight Strip Printer
FSPCU	- Flight Strip Printer Control Unit
GFE	- Government Furnished Equipment
GPI	- General Purpose Input (9020 Channel)
GPO	- General Purpose Output (9020 Channel)
KDD	- Keyboard and Data Display
NADIN	- National Airspace Data Interchange Network
NAFEC	- National Aviation Facilities Experimental Center
NAS	- National Airspace System
PAM	- Peripheral Adapter Module (9020)
PCU	- Printer Control Unit
RANK	- Replacement Alpha-Numeric Keyboard
RCU	- Remote Control Unit
RFSP(E)	- Replacement Flight Strip Printer (Enroute)
RFSP(T).	- Replacement Flight Strip Printer (Terminal)
R & M AAA	- Reliability and Maintainability Allocations, Assessments and Analysis
TELCO	- Telephone Company
TRACON	- Terminal Radar Control

1.2.2 DEFINITIONS

BUILT-IN-TEST-EQUIPMENT (BITE) - Self-test circuitry incorporated within an element or module whose purpose is to detect, diagnose, and indicate malfunctions within the element or module. The BITE self-test circuitry may be implemented using any combination of hardware and/or software.

Cathode Ray Tube Display (CRT) - An element of the FDIO Replacement System, providing display for local composition of FDEP entries and display of flight strip data.

Central Control Unit (CCU) - An element of the FDIO replacement system which resides in the ARTCC and provides interface between RCU's and GPI/GPO pairs. The NADIN concentrator may ultimately supplant the function of the CCU.

Element - An element is a unit of the FDIO Replacement System that can be independently powered up or down.

Enroute FSP - A Flight Strip Printer located in an ARTCC driven directly by the PCU.

NCP. National Airspace System change proposal (NCP) is the same as the Engineering Change Proposal. (See FAA-STD-021)

SITE ACCEPTANCE TEST (SAT) - On-site acceptance test at the government facility receiving the equipment.

FACTORY ACCEPTANCE TEST (FAT) - Factory acceptance test at the contractor's facility conducted prior to shipping the equipment.

NATIONAL AIRSPACE SYSTEM/NAS - The common network of U.S. airspace; air navigation facilities, equipment and services, airports or landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information, and manpower and material. Included are system components shared jointly with the military. The acronym NAS is also often used as a consolidation of "NAS Enroute Stage A" which is defined below.

STANDARD TEST EQUIPMENT - Test equipment such as delineated in MIL-STD-1364E or which has a Federal Stock Number (FSN).

MEAN-MAINTENANCE-TIME (MMT) - The total preventive and corrective maintenance time divided by the total number of preventive and corrective maintenance actons during a given period of time.

SERVICE LIFE - The estimated useful life of a machine after which an increase of the failure rate concomitant with technical obsolescence make further maintenance, overhaul, and servicing impractical.

FIRMWARE - Firmware is digital code incorporated in a intergrated circuit such as a programmable read only memory (PROM) which is either erasable or non-erasable.

MEAN NUMBER OF CHARACTERS BETWEEN FAILURE (MCBF) - The mean of the distribution of the time intervals between failures with characters printed continuously at maximum throughput.

CERTIFICATION - Certification is the periodic verification of the technical performance parameters.

PRINT QUALITY - No part of a character that drops out, nor is there by any ghosting, smearing, embossing, fading, or partially printed characters. The characters do not smudge after being printed. The character fill has no void. Edge definition has no intrusion. There is no spatter.

LEGIBILITY - Print characters that are clear, crisp, precise and easily legible from a normal reading distance as delineated in the equipment specification. This legibility is observed under lighting of 50-foot candles or less.

NAS STAGE A - The enroute ATC system's radar, computers and computer programs, controller plan view displays (PVD's/Radar Scopes), input/output devices and the related communications equipment which are integrated to form the heart of the automated Instrument Flight Rules (IRF) air traffic control system. This equipment performs Flight Data Processing (FDP) and Radar Data Processing (RDP). It interfaces with automated terminal systems and is used in the control of enroute IFR aircraft.

EQUIPMENT SPECIFICATION - The detail specification covering a particular equipment or system.

GOVERNMENT INSPECTION - The term "Government inspection" as used in this specification means that an FAA representative will witness the contractor's testing and inspection and will carry out such visual and other inspection as deemed necessary to assure compliance with contract requirements.

NORMAL TEST CONDITIONS - Test environment condition including the ambient temperature, ambient relative humidity and the primary voltages with permissible tolerance.

PARAGRAPH NUMBER REFERENCES - Where a paragraph number is referenced (without qualification) herein, or in the equipment specification, only the specific paragraph so numbered shall apply. Where a group of paragraphs is referenced, such as "3.3.1.2 to 3.3.1.2.3," the word "inclusive" is implied where or not actually stated. For example, "3.3.1.2 to 3.3.1.2.3" means "3.3.1.2 to 3.3.1.2.3 inclusive".

PARTS AND MATERIALS

1. PART - One piece, or two more pieces joined together which are not normally subject to disassembly without destruction of designed use, such as a resistor, electron tube, sealed bearing, bracket, etc.

2. NONSTANDARD PARTS AND MATERIALS - All parts and materials not meeting the definition for standard parts and materials are defined as nonstandard.

3. STANDARD PARTS AND MATERIALS - Standard parts and materials are those parts and materials specified in the detailed equipment specification or specified by applicable Government and industry specifications.

FAULT CONDITION - The condition where a monitoring device determines that one or more parameters of the signals sensed are outside of pre-established tolerances.

ALARM CONDITION - A condition which results when a fault has existed for a pre-established period of time.

MODULE - Two or more parts which form a portion of an assembly or a unit replaceable as a whole but having parts which are individually replaceable.

OPERATE TIME OR OPERATE PRINT TIME - The time the equipment is in actual operation by printing output.

DUTY CYCLE - The operate print time divided by equipment power on time multiplied by one hundred per cent (100%).

CRITICAL ITEM - An item that is known to be marginal in the design of the equipment, or one that must be hand selected for thermal, electrical, or mechanical performance characteristics, or a part that is operating at or near its maximum thermal, electrical, or mechanical rated specification temperature, or a part that is operating at a temperature and/or duty cycle that may degrade the equipment reliability below acceptable limits, or any nonstandard part.

LINE REPLACEABLE UNIT (LRU) - Any part, module/subassembly, or item that has been designated to be replaced at the organizational level (on-site) of maintenance (i.e. module, P.C. board, and chassis mounted electrical or mechanical part).

SHOP REPLACEABLE UNIT (SRU) - Any item that has been designated to be repaired at the intermediate (HUB) or depot level of mainteance (typically a P.C. board, submodule, and an electrical or mechanical part). An example is a piece part replacement of the failed component in the LRU. The SRU is the lowest level replacement of a component part by shop technician at the maintenance HUB.

ALTERNATING CURRENT AND VOLTAGE - Unless otherwise specified in the contract, all alternating currents and voltages shall be understood to be a root-mean-square (RMS) values.

AMBIENT TEMPERATURE AND AMBIENT RELATIVE HUMIDITY - The temperature and relative humidity of the air surrounding the equipment.

CONTINUOUS, UNATTENDED - The term "continuous unattended" means that except for scheduled maintenance periods, determined by the Government, the equipment shall operate without interruption in accordance with all contract requirements and with no need that an attendant be present.

EQUIPMENT MODELS

1. PREPRODUCTION (PROTOTYPE) MODEL - An item suitable for complete evaluation of form, fit, and performance. It is in final form in all respects, employs standard parts or nonstandard parts approved by the Government, and is completely representative of final equipment.

2. PRODUCTION MODEL - An item in its final form of final production design made by production tools, jigs, fixtures, and methods. It employes standard parts (or nonstandard parts approved by Government).

PRINT SPAN - The distance between the center lines of any two consecutive print positions.

LINE SPACING - The vertical distance between the horizontal center lines of any two consecutive lines of print.

PCB - Printed Circuit Board is circuit card assembly fully populated with all required components (i.e. IC's, sockets, heatsinks, resistors, capacitors, transitors, diodes, switches, indicators, and light emitting diodes.).

RELIABILITY TERMS - To insure precision in interpretation, the following terms defined in MIL-STD-721C are redefined for use in this specification (See APPENDIX XI) as follows:

1. FAILURE. The inability of an item to perform within limits specified in the specification.

2. ERROR. The defective printing of a received character. Some of the equipment caused errors are: the embossing, smearing, lightness, ghosting of characters, or printing of partially formed characters. Errors are also caused by operation and maintenance personnel and by other external forces.

3. FAILURE RATE. The number of failures per unit of time. It is the reciprocal of the mean time between failures.

4. ERROR RATE. The number of errors per total number of characters received and printed.

PREVENTIVE MAINTENANCE - Maintenance actions performed in an attempt to prevent an incipient failure. Preventive maintenance may include but is not limied to: lubrication, cleaning, adjusting, replacement of components having a known limited life and systematic inspection and detection.

CORRECTIVE MAINTENANCE - Unscheduled maintenance actions performed to restore a failed equipment to operation within specified performance limits.

MEAN-TIME-BETWEEN-MAINTENANCE (MTBM) - The reciprocal of the summation of the reciprocals of the mean distribution of the time intervals of corrective and preventive maintenance actions MTBM = 1/(1/MTBMp + 1/MTBMc).

MEAN-TIME-BETWEEN-MAINTENANCE-PREVENTIVE (MTBMp) - The mean of the distribution of the time intervals between preventive maintenance actions.

MEAN-TIME-BETWEEN-MAINTENANCE-CORRECTIVE (MTBMc) - The mean of the distribution of the time intervals between corrective maintenance actions. MTBMc is also equal to MTBF.

STANDARD TOOLS - Tools that are assigned National or Federal Stock Numbers (NSN or FSN) are standard tools.

PROGRAM DEVELOPMENT SET/SOFTWARE DEVELOPMENT SYSTEM - Microprocessor support equipment that enables the development of software object code and has a PROM burner is known as a Program Development Set/Software Development System.

The term "Off-the-shelf-equipment" shall mean equipment which has been produced, sold, delivered, and has performed its designed function for at least one year after delivery at the time of proposal submission. Product improvements from field experience shall be included. All units delivered that are procured from a vendor shall be identical and at a common revision level. Off-the-shelf equipment shall meet all requirements of FAA-G-2100c which the equipment specification (FAA-E-2711) notes as applicable to off-the-shelf equipment. Testing shall be conducted in acordance with Section 4.0 requirements of the equipment specification to verify compliance with all Section 3.0 requirements of the equipment specification.

GENERAL PURPOSE INPUT (GPI) ADAPTER - Receives data in a bit parallel, byte serial of up to eight bits plus parity on a demand/response basis from an input device. (9020)

GENERAL PURPOSE OUTPUT (GPO) ADAPTER - Transmits data in a bit parallel, byte serial of up to eight bits plus parity on a demand/response basis to an output device. (9020)

MEAN BENCH REPAIR TIME - Defined as the mean time to diagnose the fault, isolate and replace the faulty component, and perform those test necessary to verify the replacement unit is operating in accordance with this specification.

MEAN-TIME-BETWEEN-FAILURES (MTBF) - The mean of the distribution of time intervals betwen corrective maintenance actions. It is also the reciprocal of the failure rate. (See MIL-STD-781C).

MEAN-TIME-TO-REPAIR (MTTR) - The total corrective maintenance time divided by the number of corrective maintenance actions during a given time period, including the time to perform those tests necessary to verify that the element is operating properly.

MEAN-TIME-TO-RESTORE (MTR) - Mean time to restore is defined as the mean time to restore to an operational condition a function or equipment that has failed. The restoration may be accomplished by corrective maintenance repair, component (black-box) module or printed circuit board (PCB) replacement, or active or standby redundancy.

PERIPHERAL ADAPTER MODULE (PAM) IBM 7289-02 - Used to control many low to medium speed input/output peripheral devices of the IBM 9020 Data Processing System. These devices are attached to the 7289-02 which, in turn, is attached to the IBM 9020 System through the multiplexor channel of the IBM 7231-02 Input/Output Control Element (IOCE).

PRINTER CONTROL UNIT (PCU) - An element of the FDIO Replacement System which drives the RFSP(E)s, and in turn interfaces with the 9020 via a GPI/GPO pair.

REMOTE CONTROL UNIT (RCU) - An element of the FDEP Replacement System which interfaces the CCU via a Modem Line and interfaces the RFSP, RANK, and CRT via local serial cables. The RCU may ultimately interface with a NADIN concentrator via leased lines.

REPLACEMENT FLIGHT STRIP PRINTER (RFSP(E) or RFSP(T)) - An element of the FDIO Replacement System, that replaces the existing Flight Strip Printers, Enroute and Terminal, respectively.

2. APPLICABLE DOCUMENTS

2.1 GENERAL. - The following documents, of the exact issue as listed below, form a part of this specification and are applicable to the extent specified herein.

2.1.1 FAA ORDERS

FAA ORDER 1830.2	Policy for use of Telecommunications Data Standards.
FAA ORDER 6000.15A	Certification of Airway Systems, Subsystems and Equipment.
FAA ORDER 6950.19	Practices and Procedures for Lightining Protection, Grounding, Bonding and Shielding Implementation.
FAA ORDER 6950.20	Fundamental Considerations of Lightining Protection, Grounding, Bonding and Shielding.

2.1.2 FAA SPECIFICATIONS

FAA-G-1210d	Provisioning Technical Documentation.
FAA-G-2100c	Electronic Equipment, General Requirements.
FAA-D-2494/1	Part 1 - Instructon Book, Manuscripts, Technical Equipment and Systems Requirements, Preparation of Manuscript.
FAA-D-2494/2	Technical Instruction Book Manuscripts: Electronic, Electrical, and Mechanical Equipment, Requirements for Part II- Preparation of Reproducible (Camera -Ready) Copy and Original Artwork.
FAA-E-2552a	TECHNICAL TRAINING
FAA-E-2661a	National Airspace Data Interchange Network (NADIN).

2.1.3 FAA STANDARDS

FAA-STD-010c	Graphic Symbols for Digital Logic Diagrams.
FAA-SRDS-140-SDS-1	Software Documentation Standards for Program Development.
FAA-STD-012	Paint Systems for Equipment.
FAA-STD-016	Quality Control System Requirements.
FAA-STD-019	Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities.
FAA-STD-020	Transient Protection, Grounding, Bonding, and Shielding Requirements for Equipment.
FAA-STD-021	Configuration Management (contractor Requirements).

2.1.4 FAA PUBLICATIONS

NAS-MD-311	Message Entry and Checking.
NAS-MD-314	Local Outputs.
NAS-MD-315	Remote Outputs.

2.1.5 MILITARY SPECIFICATIONS

DOD-D-1000B	Drawings, Engineering and Associated Lists.
MIL-E-4158	Electronic Equipment, Ground General Requirements For.
MIL-E-17555G	Electronic and Electrical Equipment, Accessories and Repair Parts, Packaging and Packing Of.
MIL-P-9024G	Packaging Materials, Handling and Transportability System and System Segments, General Specification For.

2.1.6 MILITARY STANDARDS

MIL-STD-470	Maintainability Program Requirements (for Systems and Equipment).
MIL-STD-471A	Maintainability/Verification/ Demonstration/Evaluation.
MIL-STD-721C	Definition of Terms for Reliability and Maintainability.
MIL-STD-756B	Reliability Modeling and Prediction.
MIL-STD-781C	Reliability Design Qualification and Production Acceptance Tests: Exponential Distribution.
MIL-STD-785B	Reliability Program for Systems and Equipment Development and Production.
MIL-STD-1364E	Standard General Purpose Electronic Test Equipment

2.1.7 MILITARY PUBLICATIONS

MIL-HDBK-217-D	Reliability Prediction of Electronic Equipment.
MIL-HDBK-472	Maintainability Prediction.

2.1.8 FEDERAL STANDARDS

FED-STD-595A	Colors
FIPS PUBLICATION 1	Code for Information Exchange.
FIPS PUBLICATION 16	Bit Sequencing of the Code for Information Interchange in Serial-By-Bit Data Transmission.
FIPS PUBLICATION 17	Character Structure and Character Parity Sense for Serial-By-Bit Data Communication in the code for Information Exchange.
FIPS PUBLICATION 71	Advanced Data Communication Control Procedures (ADCCP)
FEDERAL STANDARD 1020	Telecommunications: Electrical Characteristics of Balanced Voltage Digital Interface Circuits.
FEDERAL STANDARD 1031	Telecommunications: General Purpose, 37-position and 9-position Interface between Data Terminal Equipment and Data-Circuit Terminating Equipment Employing Serial Binary Data Interchange.
FEDERAL STANDARD 1005	Telecommunications: Coding and Modulation Requirements for Non-diversity 2400 Bit/Second Modems.
	21 Code of Federal Regulations (CFR), U.S. Department of Health, Education and Welfare, X-Radiation Safety Rules.

2.1.9 INDUSTRY STANDARDS AND DOCUMENTS

IBM FORM L27-3008-1	IBM Flight Data Entry and Printout Equipment Component Description.
IBM FORM A27-2709-1	IBM 9020 System Input/Output Operations Reference for IBM 7289-02 Peripheral Adapter Module (PAM).
EIA-RS-310C	Electronic Industry Association: Racks, Panels, and associated Equipment.
ANSI X3.66-1979	American National Standard for Advanced Data Communication Control Procedures (ADCCP).

2.2 PRECEDENCE OF DOCUMENTS

When requirements of ths specification and the subsidiary documents referenced herein are in conflict, this specification shall have precedence.

The order or precedence of listed subsidiary documents is in the decreasing order of importance as follows:

paragraph 2.1.1 (most important)

paragraphs 2.1.2, 2.1.3, 2.1.4, 2.1.9, 2.1.8, 2.1.6, 2.1.7, and 2.1.5 (least important)

2.3 SOURCE OF DOCUMENTS

2.3.1 SOURCE OF FAA DOCUMENTS - Copies of the applicable FAA specifications and drawings may be obtained from the Federal Aviation Administration Washington, D.C. 20591, Attn: Contracting Officer. Requests should fully identify material desired; i.e., specification number, dates, amendment numbers; complete drawing numbers; also, requests should identify the invitations for bid, request for proposals, or the contract involved, or other use to be made of the requested material. The source of FAA documents is the same as in paragraph 2.3.3.

2.3.2 SOURCE OF MILITARY DOCUMENTS - Single copies of the Military Specifications may be obtained from the Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Penn., 19120. Requests should cite the request for proposals or contract for which the specifications are needed. (For telephone requests call 215-697-3321, 8 a.m. to 4:20 p.m. Mon through Fri). NOTE: More than five items may be ordered on a signed request and the invitation for Bid or Contract number should be cited where applicable.

2.3.3 SOURCES OF OTHER DOCUMENTS - Copies of the IBM documents identified in (2.1.9) may be obtained from Federal Aviation Administration, Contracts Division, ALG-300, 800 Independence Avenue, S.W., Washington, D.C. 20591. Request should cite the FDIO Request for Proposal Number.

Information on obtaining copies of Federal specifications and standards may be obtained from General Services Administration Offices in Washington, D.C.; Auburn, Washington; San Francisco, California; Denver, Colorado; Kansas City, Missouri; Atlanta, Georgia; Chicago, Illinois; New York, New York; Boston, Massachusetts; New Orleans, Louisiana; Fort Worth, Texas; and Los Angeles, California.

Information on obtaining copies of the standards issued by the American National Standards Institute may be obtained from the American National Standards Institute, 1430 Broadway, New York, 10010.

Information on obtaining copies of Electronic Industry Association Standard may be obtained for Electronic Industries Association, 2001 Eye Street, N.W., Washington, D.C. 10006.

Copies of the Federal Information Processing Standards (FIPS) may be ordered from: National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, Virginia 22161., phone number 703-487-4656.

Copies of the applicable FAA documents (i.e. Specifications and Standards) may be obtained from the Federal Aviation Administration, Washington, D.C. 20591, Attention: Contracting Officer, Code ALG-300.

For FAA NAS - MD-XXX type documents the following FAA address shall be used:

FAA Technical Center
ACT-64A
NAS Documentation Facilty
Atlantic City, New Jersey 08405

Phone Number: (609) 641-8200
Extension 2603
Government workdays
8:00 a.m. to 4:30 p.m. EST.

3. REQUIREMENTS

3.1 GENERAL

The Federal Aviation Administration operates 20 Air Route Traffic Control Centers (ARTCCs) within the continental United States, whose function is to provide safe utilization of airspace for the enroute phase of flight. Among the many services performed by the ARTCCs is the collection, processing and dissemination of flight plan data. Processing is performed at the ARTCCs, and flight strip printers (FSPs) at the sector positions are used to generate flight progress strips for the enroute air traffic controllers. Collection and dissemination of data is also carried out remotely at over 200 airport facilities. These sites, predominantly Terminal Radar Controls (TRACONs) and Air Traffic Control Towers (ACTCs), have Flight Data Entry and Printout (FDEP) equipment to provide an input/output interface with the ARTCC computers.

The system specified herein replaces the existing NAS FDEP and Enroute FSP system. The FDEP hardware at remote locations communicates with ARTCCs over leased data lines. Presently, each FDEP site interfaces directly to the ARTCC 9020 via a Peripheral Adapter Module and FDEP adapter. (See IBM A27-2709-1.) In the replacement system, many FDEP remote sites will interface to a Central Control Unit (CCU) which will connect to the 9020 via a Peripheral Adapter Module and a GPI/GPO pair. Ultimately, replacement equipment for the remote FDEP locations may interface with an ARTCC via the National Airspace Data Interchange Network. The current FSP equipment is located within the ARTCC and interfaces to the 9020 Computer via a FSPCU. The replacement FSPs within the ARTCC will interface to the 9020 via a PCU and a GPI/GPO adapter pair in the 9020 PAM.

3.1.1 INTERFACE DEFINITIONS

Both the Central Control Units and the Printer Control Units of the FDIO must interface with the General Purpose Input (GPI) and General Purpose Output (GPO) adapters which are PAM resident in the 9020 Systems. Both CCUs and PCUs must send and accept data of 8 bits plus parity in bit parallel, byte serial, in the formal shown in Figure 1.

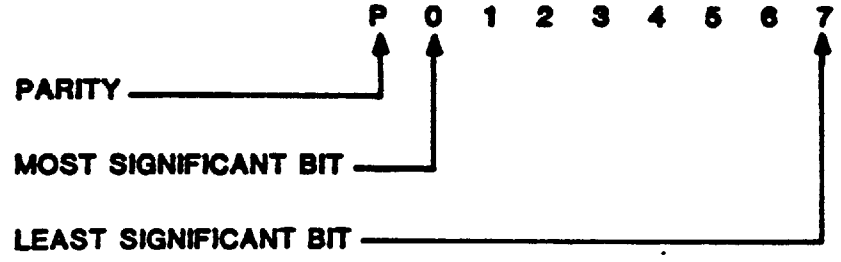

Figure 1. Format of Data Transmission

Figures 2 and 3 depict the interface characteristics and signal lines of the GPI/GPO adapters on the FDIO Control Unit device side. Detailed Adapter Interface Specifications may be found in Form A27-2709-1, IBM 9020 System Input/Output Operations Reference for IBM 7289-02 Peripheral Adapter Module (PAM).The general characteristics of the GPI/GPO adapters are described in APPENDIX XVI and XVII.

3.1.2 SYSTEM DIAGRAMS - Figures 4 through 7 illustrate the existing and replacement En Route FSP and FDEP systems. These diagrams are functional in nature and are not intended to depict all wiring or interconnections needed to meet the requirements of this specification.

3.1.3 CONTRACTOR'S RESPONSIBILITIES - The contractor shall provide the materials and services necessary to design, assemble, test, install, and integrate the replacement systems as specified herein. Installation shall be performed at sites specified by the Government. The contractor shall schedule and perform work in such a manner so as to not disrupt the normal operations of the installation site. The contractor shall provide the necessary materials and services to prepare, reproduce and provide reports, firmware listings, and documentation as specified herein. It shall be the responsibility of the contractor to meet the requirements of this specification and to provide a functioning system. Any feature or item necessary for proper system operation, in accordance with the requirements of this specification, shall be incorporated even though the item or feature may not be specifically described herein.

3.1.4 SUMMARY OF MATERIALS AND SERVICES TO BE FURNISHED - The major items of materials and services to be furnished shall include, but not be limited to those listed in table 1. Each installation shall consist of a central group or a remote group. Table 1 shows the typical make-up of Central and Remote Groups, but the exact configuration of each installation will be specified in the contract schedule. Exact numbers of Remote and Central Groups will also be specified in the contract schedule. Cabinets (with doors) utilizing equipment racks for the PCUs, CCUs, and RCUs shall be provided.

Data Lines (9)	Initiated By
Data Bit Pos. P	Control Unit
Data Bit Pos. 0	Control Unit
Data Bit Pos. 1	Control Unit
Data Bit Pos. 2	Control Unit
Data Bit Pos. 3	Control Unit
Data Bit Pos. 4	Control Unit
Data Bit Pos. 5	Control Unit
Data Bit Pos. 6	Control Unit
Data Bit Pos. 7	Control Unit

Control Lines (6)	Initiated By
I/O Request	Control Unit
Adapter Response	Adapter
Device Control 1	Adapter
Device Control 3	Adapter
Device Control 4	Adapter
EOM	Control Unit

Figure 2. - Central Control Unit (Output)/GPI Interface

Data Lines (9)	Initiated By
Data Bit Pos. P	Adapter
Data Bit Pos. 0	Adapter
Data Bit Pos. 1	Adapter
Data Bit Pos. 2	Adapter
Data Bit Pos. 3	Adapter
Data Bit Pos. 4	Adapter
Data Bit Pos. 5	Adapter
Data Bit Pos. 6	Adapter
Data Bit Pos. 7	Adapter

Control Lines (6)	Initiated By
I/O Request	Control Unit
Adapter Response	Adapter
Device Inoperative	Control Unit
Device Status Line 3	Control Unit
Device Status Line 5	Control Unit
Device Status Line 6	Control Unit
Device Status Line 7	Control Unit
Adapter Selected	Adapter
End of Message	Adapter

Figure 3. - Central Control Unit (Input)/GPO Interface

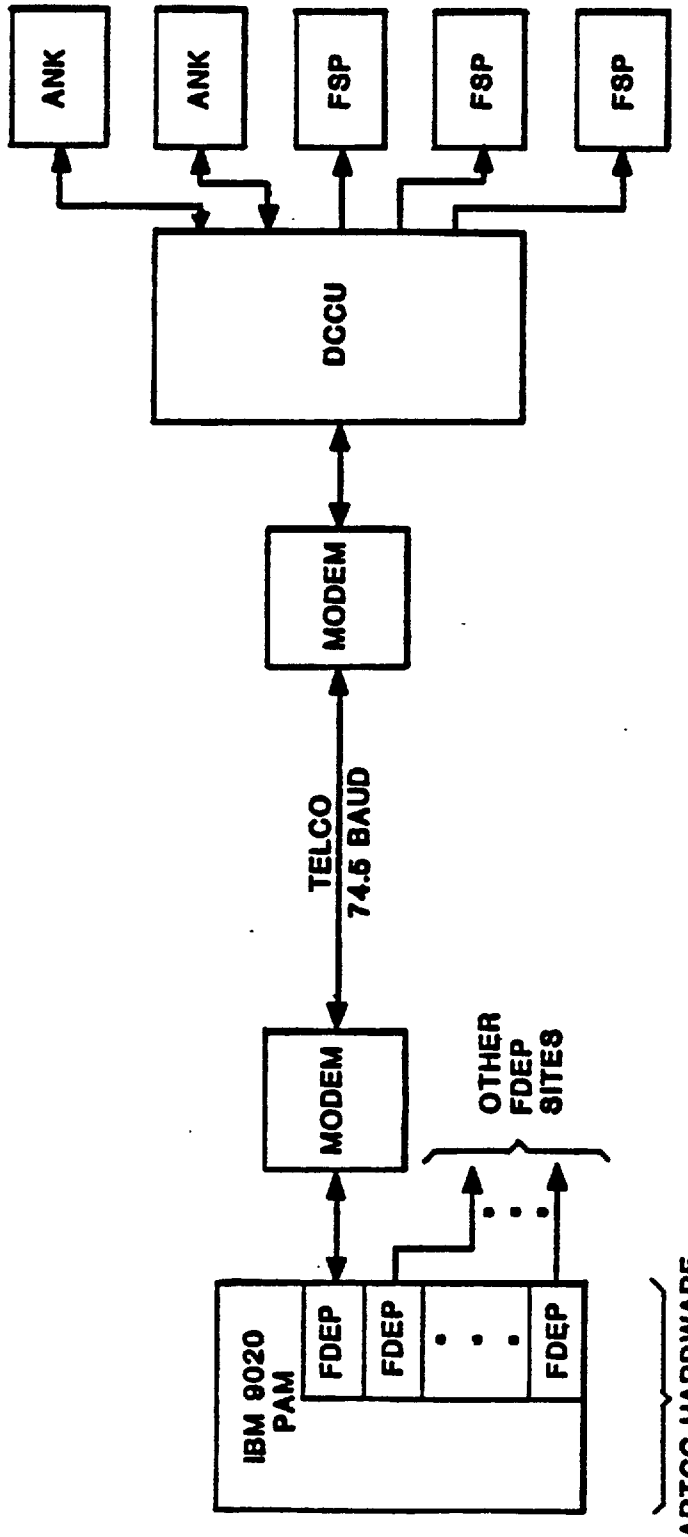

Figure 4. Existing FDEP Configuration

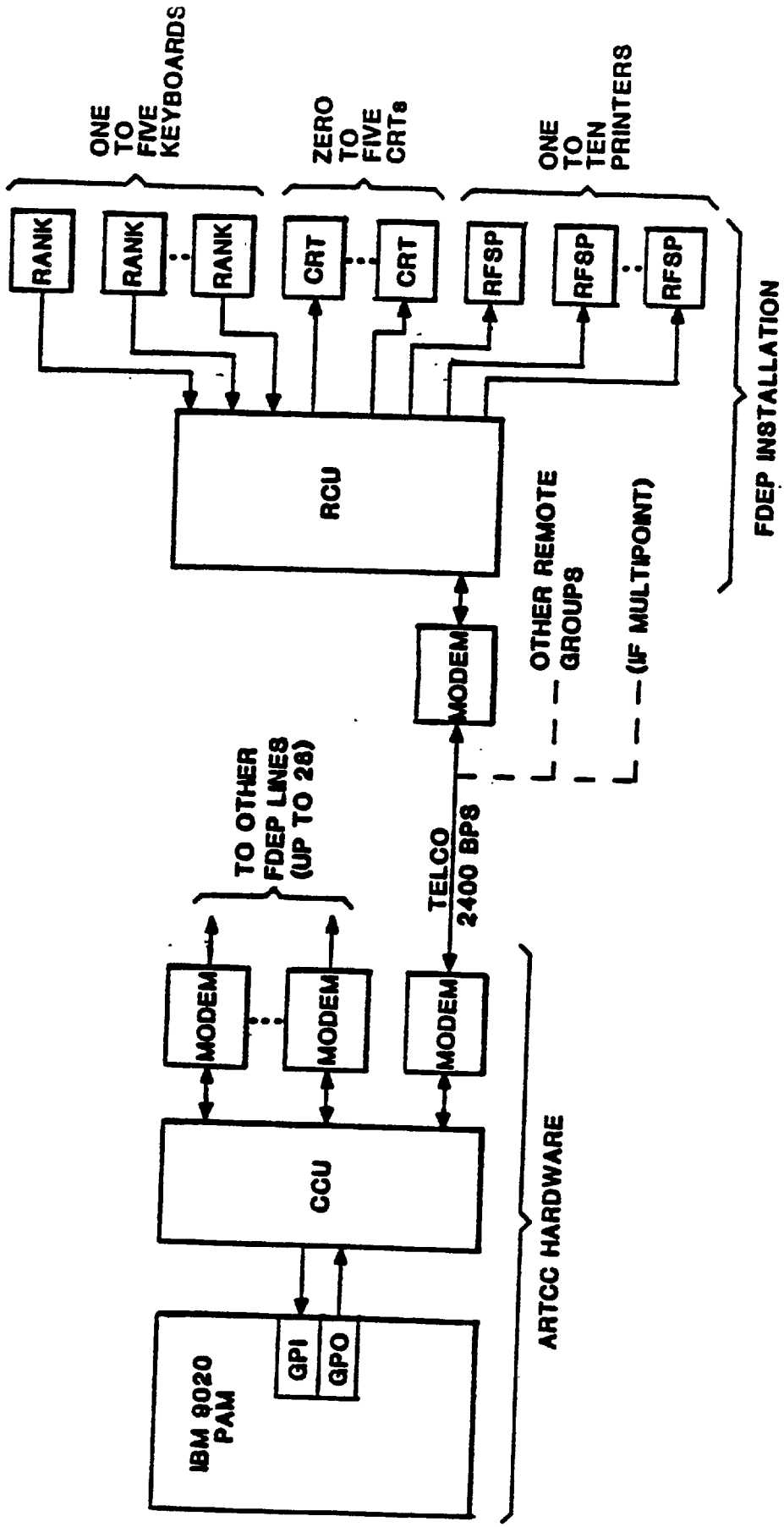

Figure 5. Replacement FDEP System

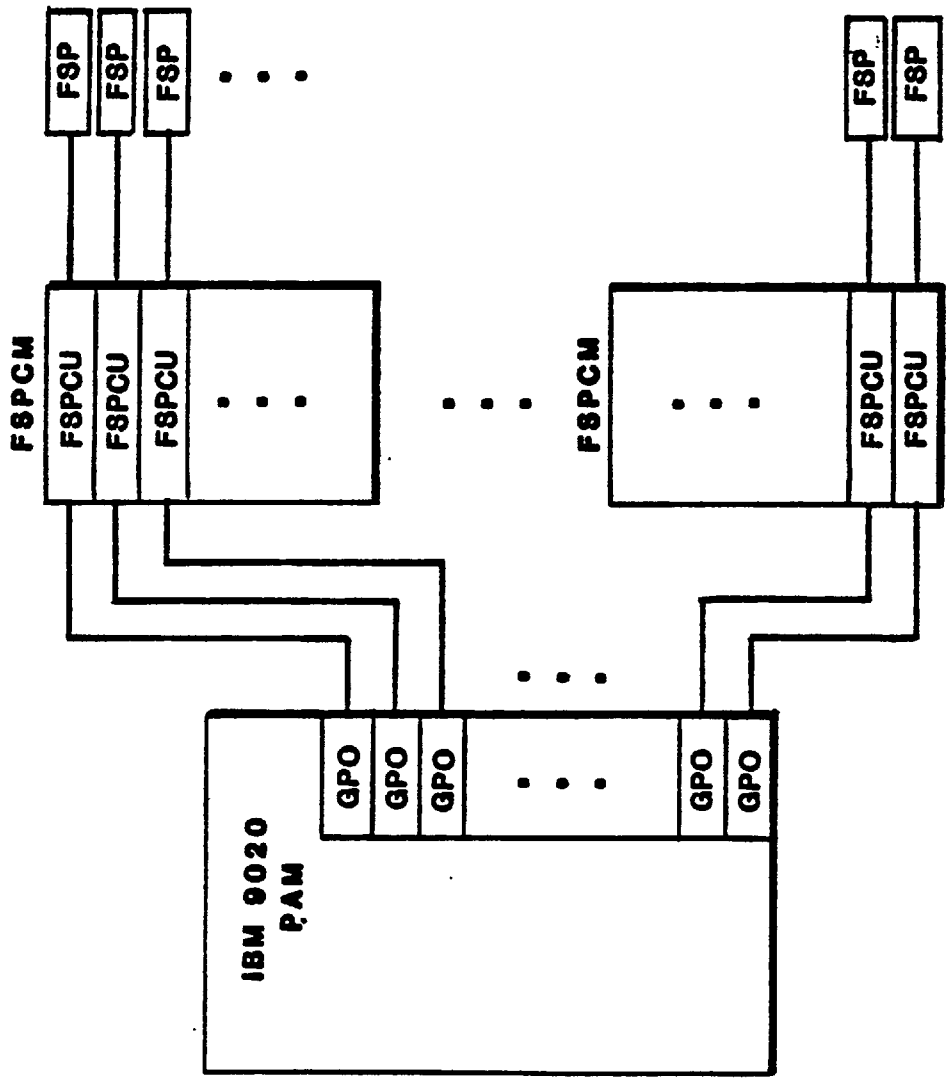

Figure 6. Existing FSP Configuration

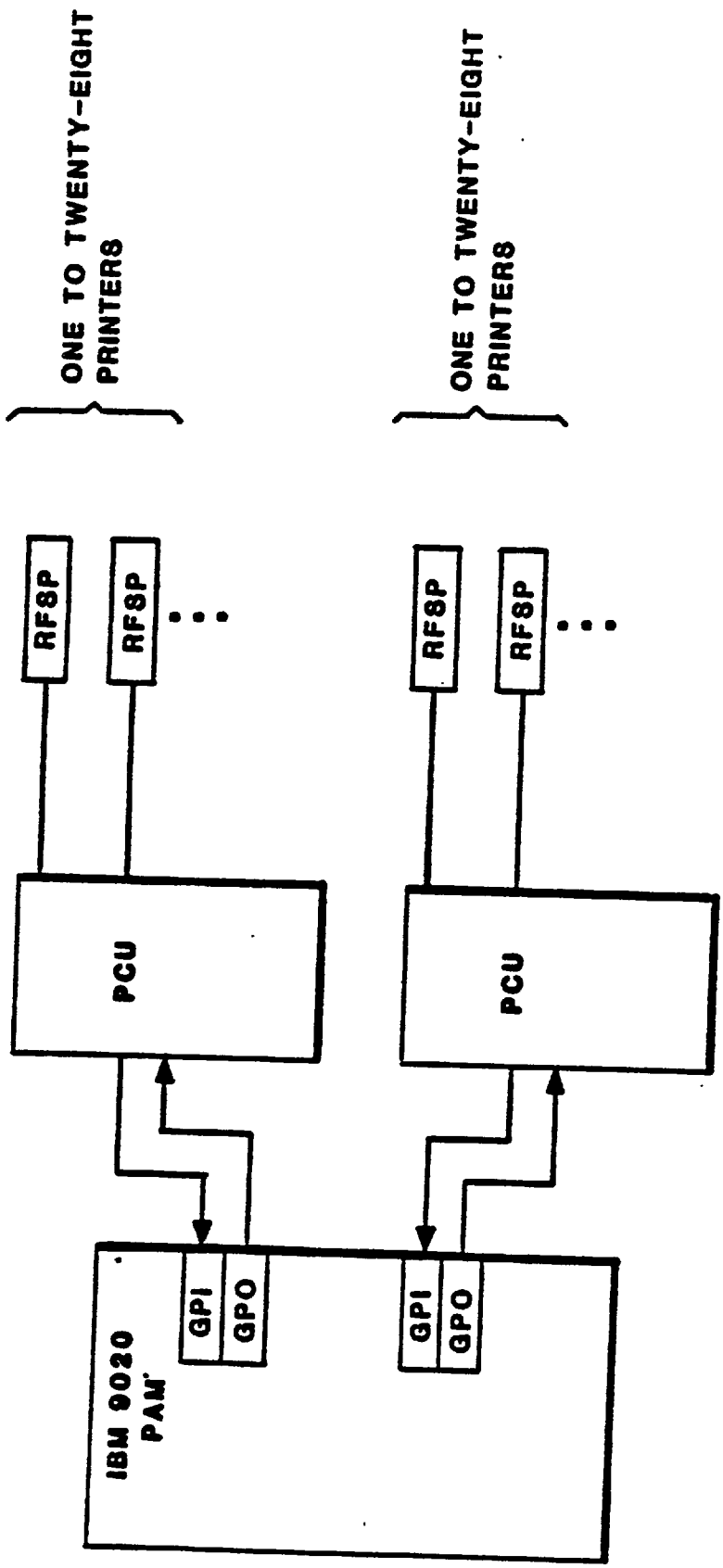

Figure 7. Replacement FSP System

TABLE 1. - MATERIALS AND SERVICES TO BE FURNISHED

ITEM	QUANTITY
CENTRAL GROUP	
Central Group Unit (Including redundancy) (optional, see contract schedule)	2
Printer Control Unit (Including redundancy)	4
Replacement Flight Strip Printers, Enroute (RFSP(E)	50 (approx.)
REMOTE GROUP	
Remote Control Unit (RCU)	1
Replacement Alphanumeric Keyboard (RANK)	2
CRT (optional, see contract schedule)	2
Replacement Flight Strip Printer, Terminal (RFSP(T))	3
MISCELLANEOUS ITEMS	
Installation support (including integration and checkout)	
Documentation (including firmware listings) Automated NAS Documentation (Optional in contract schedule), Spare Parts and Provisioning Data, Test Bed (optional in the contract schedule), Training and Instruction Books	
FDIO/9020 Interface (optional in contract schedule)	

3.2 CHARACTERISTICS - The system which shall replace the existing FDEP system shall duplicate all of the functions of the present system while providing extended capabilities. A discussion of those functions follows. Flight strips shall be displayed, as they are in the current system, by printing on the FAA flight strip forms. In addition, a display/compose CRT unit shall be included as an option. Individual remote groups may or may not include actual CRT units, depending on physical space allotments. The CRT capability, however, shall be included as a function in all sites. Where no CRT is used, the display for message composition shall be an RFSP(T). A keyboard shall provide for data entry and error display as in the current system. The keyboard shall have illuminated keys. Two Central Control Units shall be used at each CCC and one Remote Control Unit at each FDEP site. The Central Control Units shall provide interface to the IBM 9020 via a GPI/GPO pair and shall drive up to 28 high-speed (2400bps) lines, each of which may be connected to one or more Remote Control Units. Multiple connections on a line are made possible by the multipoint protocol defined in APPENDIX I. The Remote Control Unit (corresponding to the present DCCU) shall handle local functions for up to five keyboard/CRT combinations and 10 printers. All data flow in the system, after the Central or Printer Control Unit, shall be bit serial, either synchronous or asynchronous, and shall conform to Federal Standards 1020 and 1031 or RS-232C. The Printer Control Unit shall interface a 9020 GPI/GPO pair to up to 28 RFSP(E). Data flow between Control Units shall besynchronous, at 2400bps, and shall conform to FAA Order 1830.2 with RS-232C allowed in addition to RS-449 in paragraph 5h(1) therein. Data transfers between Control Units shall be according to the CCU-RCU Interface Control Document, as defined in APPENDIX I. All Control Units will utilize firmware control store. No software will be incorporated. Synchronous protocol and record format shall be accomplished via firmware. All FDIO firmware shall be alterable using pluggable components, boards, or modules. A complete changeover shall require less than one manhour. The protocol shall be ANSI X3.66 (ADCCP) as delineated in APPENDIX I.

3.2.1 PERFORMANCE REQUIREMENTS - The FDIO hardware shall meet the following minimum performance requirements.

3.2.1.1 SYSTEM - The FDIO System concept evolved from a need to increase the reliability and maintainability of the present system. Increases in flight traffic and resultant data loads have caused delays in the processing of data sent to and from FDEP sites, and to FSPs. It must satisfy input and output requirements as specified in NAS-MD-311, NAS-MD-314, and NAS-MD-315, respectively, between an ARTCC and 28 FDEP Sites, and to RFSPs(E).

All control units shall be designed so that the system configuration information is conveyed by the cables fastened to the control unit connectors. The plug ends shall be coded by jumper wires so that firmware decoders type of device information. The condition where no cable is connected shall be detected and shall not result in system disfunction and shall not be considered as a continuous error condition as long as at least one RANK and one CRT/RFSP is connected.

The system shall be designed so that there is no single point of failure within a central group. Each active CCU and PCU shall have as a backup the remaining CCU and PCU for redundancy, NOTE: the quantity two (2) as shown in Table 1. If a CCU or PCU failure occurs, the system shall be operable using the redundant CCU or PCU. An alarm indication must be given in case of failure. If an RFSP(E) fails, system operation shall automatically continue with the flight strips intended for that printer sent instead to a designated backup. If a remote group fails, the central group shall continue to function with the remaining remote groups. Failure of a remote group shall not result in lost or imperceivably altered data.

The equipment (i.e., CCU) may have the capability of a failed component to be repaired and reintegrated into the system while the remainder of the system continues operation and has the following features: No single point (module/component) failure shall stop or contaminate the system operation, and board/module (i.e., includes power supply) replacement shall take place without powering-down.

If an RFSP(T) fails, messages intended for that printer shall automatically be sent to a designated backup, if one is available.

The backup configuration required shall be the same at all ARTCCs.

3.2.1.2 REMOTE GROUPS - The remote group must provide the capabilities of the existing DCCU, ANK and FSP. The requirements for the remote group are as follows:

a. Communicate with the central group in accordance with FAA Order 1830.2, Policy for Use of Telecommunications Data Standards, with RS-232C allowed in addition to RS-449 in paragraph 5h(1) therein. The protocol shall be ANSI X3.66 (ADCCP) as delineated in APPENDIX 1.

b. Provide expandability up to five RANKS/CRTs and ten RFSPs.

c. Provide serial data flow between all units of the remote group via RS-232C or RS-449 balanced-only interfaces (EIA-RS-422 to EIA-RS-232C conversion permitted), in accordance with Federal Standards 1031 and 1020, at a rate which will not constrain the print rate of the RFSP(T).

d. Provide, within a remote group, the capability for one to five interfactive display positions. An interactive display position consists of a RANK in combination with either a CRT or a RFSP.

e. Provide, within a remote group, for composition, editing, error checking and buffering of complete entry messages. Upon entry of a transmit or end of text character, by the operator, the message shall be checked for the compositional errors as specified in NAS-MD-311 Message Entry and Checking. If errors sites are detected, the RCU shall flag the field in error. On systems with CRT displays, correction of erroneous input messages shall be possible without re-entering the entire message using cursor positioning and insert/delete/overtype capabilities.

On systems with Replacement Flight Strip Printer (RFSP), correction of erroneous input messages shall be possible without re-entering the entire message using insert/delete overtype capabilities. Once a message has been verified to be of the proper format, the message shall be transmitted to the CCU. The composition editing of entry messages on the RANK/CRT shall not affect the receipt or printout of flight strip data on the RFSPs. The entire message need not be printed on the RFSP(9T) if erroneous input is detected.

f. Data flow shall be a minimum of 2400 bps to/from the CRT and 1200 bps to/from the RANK.

3.2.1.3 CENTRAL GROUP - The central group consists of Central Control Units, Printer Control Units and RFSP(E)s. The Central Group performance requirements shall be:

a. Act as a multiplexer - demultiplexer and message router for a up to twenty-eight FDEP lines. Refer to APPENDIX II, 9020 CCC-CCU Interface Control Document.

b. Provide link protocol per 3.2.1.2. (a) and APPENDIX I, CCU-RCU Interface Control Document.

c. Act as a message router for up to 56 RFSP(E)s, (two PCUS) including maintenance channel. Refer to APPENDIX II, 9020 CCC-FDIO. Control Unit Interface Control Document.

d. Provide serial data flow between CCU and modems via RS-232C and provide serial data flow betwen the PCU and RFSPs via RS-232C or RS-449 (EIA-RS-422 to EIA-RS-232C conversion permited) balanced only interface.

3.2.2 PHYSICAL REQUIREMENTS - The system specified, herein is required to replace existing hardware. In general, the physical requirements are dictated by the equipment environment. If a RANK, CRT, and RFSP cannot all fit in the physical space presently occupied by the ANK-FSP combination, then the RFSP output characters must be visible on CRT with tilt rotate base as they are generated, for purposes of local composition. Cabinets with doors utilizing equipment racks for the PCU, CCU, and RCU shall be provided.

3.2.3 ENVIRONMENTAL CONDITIONS - The replacement components shall operate within specification limits during and after exposure to the environments given in 3.2.3.1. and 3.2.3.2.

3.2.3.1 OPERATING ENVIRONMENT

a. Temperature. 50°F - 100°F

b. Relative humidity. 20 % - 80% non-condensing

c. Altitude. Up to 8000 feet.

d. Maximum temperature gradient. 15° F/hour.

3.2.3.2 NON-OPERATING ENVIRONMENT - (TRANSPORTABILITY)

a. Transportability considerations shall be in accordance with MIL-P-9024G, paragraphs entitled "Transportability," "General Requirements, preparation for movement and handling," "Restraining Systems", "Air Transportation," "Highway Transportation", "Railway Transportation," "Shock-Vibration Transmission," "Natural Environment," and "Hazardous/Dangerous Materials." Shipping range and non-operating range -20°F to 140°F (~~-20.9~~°C to 60°C.)

-28.9°C (Mod 4)

3.3 DESIGN AND CONSTRUCTION - The system shall be designed to meet the reliability and maintainabiity specifications contained herein, and in accordance with good commerical practices for a computer system of this type.

3.3.1 BUILT-IN TEST EQUIPMENT - The FDIO system shall be maintainable without use of special purpose test equipment, except at maintenance hubs. Each element shall be provided with malfunction indicators and shall maximize use of Built-In Test Equipment (BITE).

3.3.2 DATA ERRORS - The FDIO shall be designed to eliminate data errors. To accomplish this, each element of the replacement system shall incorporate data error detection and retransmission techniques as appropriate to ensure data integrity while minimizing data traffic and required human intervention. The CCU-RCU interface shall employ the "American National Standard for Advanced Data Communicaton Control Procedures" (ADCCP) protocol as specified in ANSI X3.66 (January 9, 1979), FIPS Publication 71. This protocol is described in APPENDIX I, which also lists references for additional information. This protocol shall be employed for traffic originated both by the CCU or any RCU. Data transmission deemed acceptable at the RCU shall be decoded and forwarded to the appropriate CRT terminal or Flight Strip Printer. Data output from the RCU to the terminal/printer shall be bit serial, ASCII encoded characters and control with parity. The terminal/printer shall recompute and compare parity with that received. In the event of a detected error, the character in question shall be rejected and retransmitted and if an error still exists then the terminal/printer will display an error-indicating character and flag the error condition to the RCU. All the received data shall be verified at the last possible point in the electro-mechnical process. In the event that the RCU receives an error from the printer/terminal, the entire message shall indicate that it is a corrected message. Repeated failed transmissions shall result in a audible alarm for operator intervention. The printer/terminal shall acknowledge to the PCU/RCU the receipt of a message after completion of the message output. Failure to receive such an acknowledgement at the RCU/PCU shall result in a repeated transmission. If acknowledgement is still not received, an audible alarm shall be made for operator intervention.

For power outages, the system shall be designed to recover automatically with no lost or imperceivably altered data, provided that a power failure does not occur both in the Central Group and the Remote Group at the same time. Each PCU and CCU shall have a separate power source of 115 VAC supply.

3.3.3 METALS - All metals used in the equipment shall be suitably coated or protected against corrosion. Dissimilar metals shall not be used in direct contact with each other, except as required for electrical interconnection.

3.3.4 LUBRICANTS - All lubricants necessary to sustain proper operation of the equipment shall be interchangeable with at least one other lubricant product of a different manufacturer. Lubricants should not be special purpose types and should have a National Stock Number (NSN)/Federal Stock Number (FSN).

3.3.5 MAINTAINABILITY AS A DESIGN GOAL - The equipment shall be completed with all plug-in parts and other parts that are used in the equipment and are designed for quick removal and replacement. The equipment shall be mechanically designed and constructed to permit ready access to all modules, printed circuit boards, assemblies or other equipment items or parts. The equipment design and construction shall provide access to all parts, test points, terminals, and wiring for circuit checking, adjustment, maintenance and repair without requiring the partial or complete removal of any nearby module, part or portion of the equipment.

3.4 CHARACTERISTICS OF SUBORDINATE ELEMENTS - The following are the performance and physical requirements of the elements of the FDIO which make up the cental and remote groups.

3.4.1 PERFORMANCE

3.4.1.1 CENTRAL CONTROL UNIT - The CCU shall be constructed using microprocessor technology. Table 2 presents a list of hardware which may meet the requirements of this specification. (This list does not impose any limitation on the contractor nor is it to be interpreted as a recommendation by the Government). The enumerated performance requirements of the CCU are as follows:

a. Provide serial/parallel and EBCDIC/ASCII conversion. Refer to APPENDIX II, 9020 CCC-FDIO Control Unit Interface Control Document, and APPENDIX F of FAA-E-2661a.

b. Provide multiplexing/demultiplexing of up to 28 high-speed (2400 bps) FDIO lines, each of which may be connected to one or more remote groups.

c. Provide data error detection/retransmission as required on data to/from the RCU. The CCU/RCU interface protocol shall be the ADCCP protocol (ANSI X3.66) as described in APPENDIX I.

d. Provide local buffering of messages, both incoming and outgoing. A minimum of 16K bytes of memory shall be utilized for local storage of incoming and outgoing messages. This buffer will be designed to allow high accessibility to the CCU by the 9020 and to provide for retransmissions as necessary without the need for interrogating the messsage originator. Messages shall be processed on a first-in, first-out basis. The FDIO CCU shall operate on the critical bus Power Conditioning System (PCS).

e. Provide both on and off-line self diagnostics.

f. Provide self-initiating operation upon the application of power.

g. Provide a switching mechanism such that all input and output signal lines to the CCU can be made available to its redundant CCU and so that the operational CCU of the pair can initiate the switching over of control to the redundant unit. A single-action manual means for accomplishing this switch from one control unit to another shall also be provided. Visual indication of the status (active/backup) of each CCU is required.

TABLE 2 - LIST OF HARDWARE

Controllers

Data General Micro-Nova Series

Digital Equipment Corp LSI 11-23 Series

Intel SB-80 Series

Motorola Micromodule Series

Texas Instruments 990/110 Series

Printers

Centronics Model 737

Dataproducts D-50

General Electric Terminet 120

Integral Data Systems Model 460

Qume Sprint 3 and 5 Series Receive Only Printer

Teletype Model 40 Forms Access Printer

Xerox 1750 Receive Only Printer

Keyboards

Amkey (custom)

Cherry (custom)

Digitron (custom)

Micro-Switch (custom)

Cathode-Ray Tubes

Conrac

Ramteck

3.4.1.2. REMOTE CONTROL UNIT - To facilitate spare parts provisioning and training, the RCU shall be constructed using hardware modules that are the same as those used to construct the CCU and PCU, where possible. The performance requirements of the RCU are as follwows:

a. Functionally replace the DCCU.

b. Provide serial output ports to CCU, RANK, RFSP(T) and CRT.

c. Be designed to service an expanded Remote group as specified in 3.2.1.2d, and 3.2.1.2b.

d. Provide data error detection/retransmission on data to/from the CCU. This shall be implemented using ADCCP protocol as described in APPENDIX I.

e. Provide self-initiating operation upon the application of power.

f. Provide both on and off-line self diagostics.

g. Provide data error detection/display on data to/from RANK and CRT and RFSP(T). The RCU shall respond to error conditions form the terminal/printers and retransmit messages as necessary.

h. Provide local buffering of messages, both incoming and outgoing. The RCU shall buffer messages incoming from the CCU until positive message acknowledgement has been received from the terminal/printer. Outgoing messages from the RANK shall be buffered by the RCU until the CCU acknowledges receipt of the messages. A 16K byte minimum memory shall be provided for this buffering.

Messages shall be processed on a first-in, first-out basis. The FDIO RCU shall operate on the critical bus Power Conditioning System (PCS).

i. Monitor keyboard entries for errors in format and entry range.

j. Provide error message display, via RFSP(T) or CRT, or both including errors detected in e, f, h, and j.

k. This space is intentionally left blank.

l. Provide hardware/firmware design to allow either a CRT or a RFSP(T) to operate in conjunction with a specific RANK as the interactive display. The system design requires that this switchover be automatic. It is suggested that physical assignment of RANK/RFSP(T) or CRT interactive pairs be accomplished by connector coding and physical connection.

m. The connection or disconnection of any peripheral and a control unit shall be sensed by the system, and shall cause an alert to be issued on the appropriate output device(s). However, the system shall automatically adapt to the new configuration without operator interaction. The RCU shall reconfigure the network of printers, keyboards, and CRTS under program control to respond to failures in the individual units and to enable operational position combinations within the TRACON. This is standard configuration at all remote sites.

n. Provide an additional port with an RS-232C or RS-449 interface, the use for which is not yet defined.

o. Provide a "maintenance" channel(s) which shall be used for exercising a RANK, CRT, or RFSP in a maintenance mode as an aid for diagnostics and checkout. The use of this channel shall not interfere with normal operation. The maintenance channel(s) shall have both local and remote control capability for maintenance purposes.

p. Provide the discrimination and control necessary to print numeric information (digits 0-9) on flight strips in upper and lower case size, depending upon the field format as defined in NAS-MD-314 and NAS-MD-315. Numeric information shall pass between the CCU and RCU in USASCII code (as defined in FIPS PUB 1) only; i.e., no separate encoding of upper and lower case numbers shall be used except across the RCU-RFSP interface and the PCU-RFSP interface.

3.4.1.3 PRINTER CONTROL UNIT - The printer control unit shall be constructed using hardware modules that are the same as the CCU and the RCU. The performance requirements of the PCU are as follows:

a. Provide parallel/serial and EBCDIC/ASCII conversion. Refer to APPENDIX II, 9020 CCC-FDIO Control Unit Interface Control Document Award, APPENDIX F of FAA-E-2661a.

b. Provide multiplexing/demultiplexing for up to 28 RFSP(E)s.

c. Provide for data error detection/display for data flow between PCU and RFSP(E)s. The PCU shall detect error status from the RFSP(E)s and retransmit the message in its entirety upon receipt of an error status. In the event of the failure of an RFSP(E), the flight strips intended for that printer shall automatically be sent instead to a designated backup. The PCU shall acknowledge to the IBM 9020 when each message has been printed.

d. Provide self initiating operation upon application of power.

e. Provide both on and off-line self diagnostics.

f. Provide local buffering of messages. The PCU shall provide sufficient local buffering to allow retransmission as required to the FSP without the need to interrogate the 9020. A 16K byte minimum memory buffer shall be utilized for incoming messages. Messages shall be processed on a first-in, first-out basis. The FDIO PCU shall operate on the critical bus Power Conditioning System (PCS).

3.4.1.2.0.

g. Provide a secondary "maintenance" output channel as in 3.4.1.2.p., for use in exercising an RFSP(E) only. The character set shall include a printable error indicating character for use in parity error conditions. The PCU shall check all parity before accepting data.

h. Provide a switching mechanism such that all input and output signal lines to the operational PCU can be made available to its redundant PCU, and so that the operational PCU of the pair can initiate the switching over of control to the redundant unit. A single-action manual means for accomplishing this switching from one control unit to another shall also be provided. Visible indication of the status (active/backup) of each PCU is required.

3.4.1.4 REPLACEMENT FLIGHT STRIP PRINTER - The following are the performance requirements for the RFSP(T)s and RFSP(E)s:

a. Provide an RS-232C or RS-449 balanced-only interface (EIA-RS-422 to EIA-RS-232C conversion permitted) compatible with both RCU and PCU.

b. Accept USACII code, as defined in FIPS PUB1, with the following exceptions.

1. "Opening Brace" shall be printed as the South (downward) direction arrow;

2. "Closing Brace" shall be printed as the North (upward) direction arrow, and

3. Ten codes normally assigned to graphic characters which are not required for the RFSP (see 3.4.1.4(d) below), shall be assigned (at the contractor's discretion) and printed as upper case numerals (0-9).

c. Capable of printing at a minimum rate of 30 characters per second.

d. Print a character set the same as printed by the existing FSP (see L27-3008-1), with the following deletions:

1. The East (right) and West (left) direction arrows

2. The four weather symbols

3. The rectangle; and

4. The "four lines."

The character set shall include a printable error indicating character for use in parity error conditions.

e. Provide visible and audible out-of-forms indications and stop transmission from the control unit.

(Mod 4) f. ~~The RFSP(E)~~ All RFSP(s) shall provide a red-black highlighting print mode.

g. The RFSP shall receive, recompute and compare parity on each character received. In the event of a parity error, the printer shall flag the error condition to the RCU or PCU as appropriate for retransmission.

h. The RFSP shall provide positive acknowledgement of message receipt to the PCU or RCU as appropriate.

3.4.1.5 REPLACEMENT ALPHA-NUMERIC KEYBOARD - In general, the RANK must effectively generate and transmit to the RCU all 128 USACII graphic and control character codes. The performance requirements for the RANK are as follows:

a. Generate the USASCII codes (as defined in FIPS PUB1) corresponding to the key assignments shown in Table 3. Depressing a single key shall generate the code for the character shown in the "Lower Case" column. Depressing a key while SHIFT is held down shall result in a character in the "Shift" column. Holding down CONTROL and depressing a key shall produce a character in the "Control" column. Those characters shown in Table 3 in parentheses shall not be labeled on the keyboard (the layout for which shown in Figure 8).

b. Generate control codes corresponding to the cursor control and local editing functions of keys shown in Figure 8.

c. Generate control codes in response to depression of ENTER and unused blank keys.

3.4.1.6 CRT DISPLAY - There is no direction correlation between the CRT and existing hardware. In general, the CRT shall be a stand alone unit, interfaced to the RCU. It will be used in association with a RANK, as a viewing area for the composition of mesages, but is not directly interfaced to it. The CRT shall meet the following performance requirements.

a. The CRT display shall show 24 lines of up to 80 characters each. This display have internal automatic refreshing. The displayed message shall be modified by either keyboard control or signals from the RCU. Fields or groups of lines may be designated as protected fields not accessible from the keyboard. The CRT display can thus function as an output device and local message composition preview area concurrently. The CRT shall have the capability of the protected fields, a feature selected by the contractor and approved by the Government.

b. The CRT display shall have a character set corresponding to the character keys found on the RANK and shall be capable of displaying all characters available on the RFSP (see 3.4.1.4 (d)). The character set shall include a unique error indicating character identical to that utilized on the Flight Strip Printer. A blinking cursor shall identify the next screen location to be modified. The characters shall be composed within a minimum 9 wide by 12 high (9 X 12) dot matrix (7 X 9 dot character). The characters shall have a nominal aspect ratio, width to height, of 0.6 to 0.8. Characters any where on the display surface shall not exhibit a size variation, in either height or width, greater than 15 percent (using the formula maximum minus minimum over average of maximum and minimum, times 100 percent). The character font must have the approval of the Government prior to implementation by the contractor.

c. The display presentation shall be flicker-free with a 60 cycle refresh non-interlaced.

d. CRT display operating controls shall be mounted on the front panel or operator accessible from the front. They shall consist, as a minimum, of an on/off switch, a contrast control and a brightness control.

TABLE 3

ASCII ENCODING OF FDIO KEYBOARD CHARACTERS

LOWER CASE	SHIFT	CONTROL
a	A	(SOH)
b	B	(STX)
c	C	(ETX)
d	D	(EOT)
e	E	(ENQ)
f	F	(ACK)
g	G	(BEL)
h	H	(BS)
i	I	(HT)
j	J	(LF)
k	K	(VT)
l	L	(FF)
m	M	(CR)
n	N	(SO)
o	O	(S1)
p	P	(DLE)
q	Q	(DC1)
r	R	(DC2)
s	S	(DC3)
t	T	(DC4)
u	U	(NAK)
v	V	(SYN)
w	W	(ETB)
x	X	(CAN)
y	Y	(EM)
z	Z	(SUB)
0	(SP)	
1	(1)	
2	(")	
3	(#)	
4	($)	
5	(%)	
6	(&)	
7	(')	
8	(()	
9	())	
*	(:)	
+	(;)	
-	(=)	
.	( )	
/	(?)	
@	( )	(NUL)
	( )	(ESC)
	( )	(GS)
SPACE	( )	( )
BLANK 1 (/)	( )	(FS)
BLANK 2 ( )	( )	(RS)
BLANK 3 (DEL)	(_)	(US)
BLANK 4 (,)	( )	

--CHARACTERS IN PARENTHESES ARE NOT LABLED ON KEYBOARD--

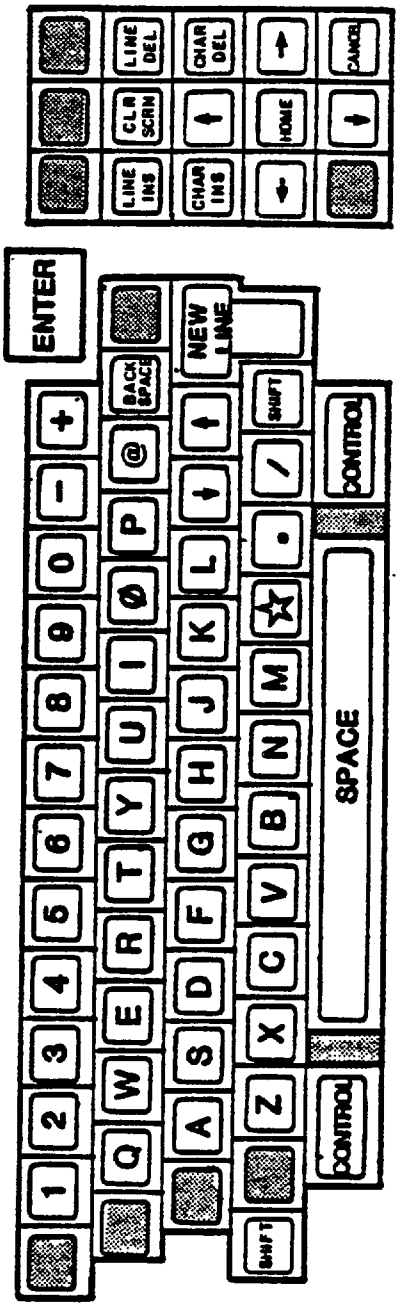

Figure 8. Rank Layout

e. The display shall have an achieveable brightness of 40 foot lamberts, measured with an ambient of 15 foot candles of incident light normal to the faceplate of the CRT. The brightness variation between or within any characters or lines shall not exceed 40 percent using the formula maximum minus minimum, over the average of maximum and minimum, times 100 percent. The brightness variation requirements shall be met over a display brightness range of from 5 foot lamberts to 20 foot lamberts. The brightness of the cathode ray tube shall not vary by more than 20 percent between different selected display positions. The percent variation is computed as stated above over the same brightness range. Brightness measurements shall be made at the same location for both presentations.

f. The display shall have a contrast ratio of at least five to one at 20 foot lamberts. For purposes of this specifiction, contrast ratio is the ratio of brightness of an illuminated position on the cathode ray tube, to a non-illuminated position adjacent to the same character.

g. The width of any line, regardless of orientation, or character segment shall not exceed 0.02 inches (0.5 millimeters). The ratio of the maximum to minimum line or character segment width shall not exceed two to one.

h. The display monitor shall have a linearity error of not more than two percent of the display height.

i. The CRT shall be equipped with a bell, buzzer, or other audible alarm which signals upon the receipt of the ASCII character "BEL." The exact device used shall be approved by the Government as to the character of sound omitted.

3.4.2 PHYSICAL - Paragraphs 3.4.2.1. through 3.4.2.7. contain the physical requirements of the FDIO subordinate elements. The FDIO shall operate from a primary power source of 115 VAC with a tolerance of ±10% and a frequency of 60 Hertz ±5%. Rapid voltage and frequency variation within the specified tolerance range shall not generate errors.

3.4.2.1 CENTRAL CONTROL UNIT

a. A standard Electronic Industries Association (EIA) 19 inch equipment rack (EIA-RS-310C paragraph 5.4) as part of a cabinet with levelers and doors (front and back) with a height not higher than 6 feet shall be supplied with the equipment.

b. Provide readily accessable connections to other units.

c. Utilize alterable firmware.

d. Consume less than 500 w at 115 VAC primary power.

3.4.2.2 REMOTE CONTROL UNIT

a. A standard Electronic Industries Association (EIA) 19 inch equipment rack (EIA-RS-310C paragraph 5.4) as part of a cabinet with levelers and doors (front and back) with a height not higher than 6 feet shall be supplied with the equipment.

b. Provide readily accessable connections to other units.

c. Utilize alterable firmware.

d. Be designed to be expandable, in hardware and firmware, to accommodate up to 5 RANKS and CRTs and up to 10 RFSP(T)s.

e. Consume less than 500 w at 115 VAC primary power.

3.4.2.3 PRINTER CONTROL UNIT

a. A standard Electronic Industries Association (EIA) 19 inch equipment rack (EIA-RS-310C paragraph 5.4) as part of a cabinet with levelers and doors (front and back) with a height not higher than 6 feet shall be supplied with the equipment.

b. Provide readily accessable connections to other units.

c. Utilize alterable firmware.

d. Consume less than 500 w at 115 VAC primary power.

3.4.2.4 REPLACEMENT FLIGHT STRIP PRINTER - In general, the RFSP shall have the same physical characteristics as the existing FSP.

a. The RFSP shall print on forms identical to the type used with the present FSP and FDEP printer, (FAA Form 7230-7.2 and 7230-19) and the supply of forms shall be attached end-to-head. The resultant strip shall be identical to that product using the above specified FAA forms.

b. Character formation without readily apparent segmentation of a DOT Matrix printer shall be legible. The character appearance shall be "Letter Quality" and legible at a distance of 5 feet by persons with vision corrected to 20-20. Character sizes shall be the same as those specified for the existing FSP (see L27-3008-1). The proposed character font shall be approved by the Government. The character size tolerances are: upper case height $\pm$ 0.009 inches, upper case width $\pm$ 0.005 inches, lower case height $\pm$ 0.005 inches, and lower case width $\pm$ 0.004 inches.

c. Character printing on on-tenth inch centers minimum. Maximum to provide compliance with print fields specified in NAS-MD-314 and NAS-MD-315 Section 4.

d. RFSPs shall provide vertical spacing capability necessary to print fields in the format specified in NAS-MD-314 and NAS-MD-315 Section 4 (approximately 5 lines per inch).

e. RFSPs in remote groups shall accommoate form lengths of one inch, and RFSPS in central groups shall accommodate form lengths of 1-1/3 inches. This requirement may be satisfied by firmware design in the RCU and PCU.

f. Provide illumination of the printed form. This lighted area should extend from the print station to one form length (1-1/3 inches) above the print station. No light shall be omitted from the top of the RFSP in a direction forward of perpendicular except the light reflected from the printed form.

g. The RFSP shall be designed to physically occupy the same space as existing FSPs. Physical characteristics for the existing FSP can be found in Form L27-3008-1 IBM Flight Data Entry and Printout Description. However, the maximum width of the RFSP shall be 17.25 inches.

h. The loading of paper shall be a simple and straightforward operation and shall require less than five minutes.

i. Printed strips shall be available for use or removable upon completion. The perforations on the paper shall facilitate the removal of paper strips via a paper separation mechanisms or tear bar. The ratio of paper strips wasted to paper strips used shall not exceed 2:1.

j. Shall consume less than 350 w at 115 VAC primary power.

k. The RFSP shall weight less than 60 pounds.

l. The noise generated by an operating RFSP must not exceed the limits specified in FAA-G-2100c paragraph 3.3.1.7.

3.4.2.5. REPLACEMENT ALPHA-NUMERIC KEYBOARD - In general the RANK must physically replace existing ANKS.

a. The RANK shall be designed to physically occupy the same space as existing ANKS ~~(approximately 14.5 inches in width, 10.5 inches in depth, and 5 inches in height)~~ OR SMALLER (mod 4). Physical characteristics for the existing ANK can be found in Form L27-3008-1 IBM Flight Data Entry and Printout Equipment Component Description.

b. Provide character and function keys in the layout shown in Figure 8.

c. Provide the following status indicators: Power On, ~~Wait (for response from RCU), Parity error.~~ AND MESSAGE WAITING (mod 4)

d. Provide illuminated keys. A brightness control shall be provided to vary the intensity of the illumination.

e. The keyboard slope and key spacing shall be similiar to the existing ANK.

f. Consume no more than 250 w at 115 VAC primary power.

3.4.2.6. CRT DISPLAY

a. The CRT Display physical dimension (Including the console cabinet mountng characteristics) shall be no greater than 18 5/8 inches in depth, 1711/16 inches in width and 17 3/8 inches in height. Mounting for the CRT display shall be console cabinet on a swivel pedestal tilt rotate base for table top mounting. The tilt rotate base shall have a tilt range of $\pm 15^{\circ}$ and a rotate range of $\pm 180^{\circ}$ and not exceed 5 inches in height. The overall height of the cabinet and base shall not exceed 22 3/8 inches.

b. The display area shall have a diagonal measurement no less than 12 inches.

c. The cathode ray tube shall have an implosion shield bonded to the faceplate. The implosion shield shall consist of a filter suitably etched to provide a non-glare surface, which is mar-resistant and may be cleaned by readily available glass cleaning solutions. A P-31 (green non-glare) type phosphor with a 50 percent matched light filter shall be used in CRT display.

d. The CRT display shall comply with the U.S. Department of Health, Education, and Welfare X-Radiation Safety Rules, 21 CFR, Subchapter J.

e. Consume no more than 250 w 115 VAC primary power.

3.4.2.7 CABLES - The contractor is responsible for all cabling.

a. The cabling used shall be suitable for RS-232C or RS-449 applications. EIA-RS-232C cabling is permitted for the off-the-shelf RFSPs, RANKS, CRTs provided that there is not any operational degradation up to 300 feet away from the PCU or RCU in an ARTCC or Tower and Tracon environment respectively. Cabling for a EIA-RS-449 to EIA-RS-232C interface conversion is permitted using the EIA-RS-422 balanced mode for the RCU and PCU connection(s)/configura-tion(s) in paragraph 3.2, Figure 5, and paragraph 3.2, Figure 7 respectively and their peripherals.

b. All cable terminations shall be clearly identified as to type, e.g. RANK, CRT, or RFSP.

c. All cables shall be identified by an alphabetic or numeric designator at both terminations. The method used for cabling shall result in a product that will survive the operating and non-operating environment specified in 3.2.3. The marking scheme must have the approval of the contracting officer prior to implementation. The equipment shall be capable of driving interconnecting cables to consoles a minimum distance of 4000 feet (1219.5 meters). The equipment referred to is the control unit (i.e., RCU, PCU, and CCU).

d. All intracabinet cabling shall be neatly and efficiently routed within the cabinet. Cable clamps, ties, or other fasteners shall be used extenisvely to securely and neatly bundle the cables and attach them to cabinet frame members. The cabling shall be designed and constructed to permit all doors and sliding units to operate freely without binding, scraping, or in any way wearing or damaging the cables. All FDIO Remote Group equipment that is not off-the-shelf shall be provided with a Hubbell 4700 series twistlock A/C power connector that will mate with a Hubbell 4700 receptacle.

e. The following average cable lengths/distances are provided:

a.	9020 PAM to CCU	-	300 ft.
b.	9020 PAM to PCU	-	300 ft.
c.	CCU to Modems	-	300 ft.
d.	PCU to RFSPs	-	300 ft.
e.	RCU to Peripheral	-	300 ft.
f.	RCU to Modems	-	300 ft.
g.	AC power distribution panel to equipment (control unit)	-	150 ft.
h.	Ground point to equipment	-	150 ft.
i.	Peripheral to local Modem (Contract Schedule, Article I, Attachment 6 Note 1)	-	300 ft.

The cable lengths shall be cut to fit as a result of site survey and reisdual cable shall become FAA property.

f. The contractor shall provide IBM Serpentine connectors for the GPI/GPO interface cables associated with the CCU and PCU. The type of IBM Serpentine connectors shall be 24 pin Type A as specified in APPENDIX XV.

3.5. DOCUMENTATION - The FDIO System shall be provided with a complete set of documents. This documentation shall include a number of specific data submissions, such as reports, firmware listings, spare parts lists, test procedures, etc., required by the various sections of this specification and the contract schedule. The documenttion shall also include all of the instruction book data related to the system design. The documentation shall be delivered for the entire system and for all equipment in the system, whether manufactured by the contractor or by another vendor. All documentation shall be supplied in accordance with the provisions of the contract schedule.

The contractor shall develop and validate engineering drawings in accordance with DOD-D-1000B to accomplish the following functions:

a. Provide all information necessary to determine layout, install, and put the lowest level items into operation within the equipment.

b. Provide sufficient detail to enable evaluation and control of physical and functional design interrelationships of interdependent items down to and including assemblies replaceable at the site organization level.

c. Provide the information necessary for identification, description, and cataloging items of supply down to and including individual repair parts and defined in paragraph 3.15 of FAA-G-1210d.

d. Provide all information required to accomplish Organization (Site), Intermediate, and Depot level maintenance on subassemblies and/or modules of the equipment.

e. Provide the necessary design, engineering, manufacturing, and quality support information to enable the procurement of all spare and repair parts to support the FDIO equipment. Spare parts must duplicate the physical and performance characteristics of the original parts.

f. The contractor's method of assigning reference designators and location coding shall meet the requirements of paragraph 3.8 of FAA-G-2100c. The method shall be defined for review by the FAA Technical Officer or Quality Reliability Officer at a progress meeting prior to implementation into the data package.

g. A mark-up of the site drawings approved by the Government are acceptable for installation, integration and implementation of the equipment.

h. Documentation shall be provided as required in the documents referenced elsewhere in this specification to permit on-going maintenance and logistics support of the FDIO after acceptance of the equipment until completion of the total contract, (i.e., last site(s) equipment delivered). Revisions reproducible quality, and identification replacements are delineated in i,j, and k.

i. REVISIONS - Documentation required shall be periodically updated to reflect the latest design level. In the event that documentation has been submited to the Contracting Officer, appropriate revision pages in the same quanity as the earlier submission shall be provided or the document updated in total if 20 percent or more of the total pages in the document require updating.

j. REPRODUCIBLE QUALITY - Reproducibles furnished shall be of such quality as to permit the reproduction of every line and character on the reproduced copy. Reproducibles of the sepia type shall have a minimum background of field density (no burned or dark areas).

k. IDENTIFICATION - Documentation produced or updated by the contractor shall show the contract number conspicuously displayed on each document, including drawings, and parts lists to facilitate identification and association with the contract.

l. A configuration "as built" list shall be provided for each piece of delivered hardware, by serial number and documented in accordance with DID UDI-E-20409B in APPENDIX III.

3.5.1 SYSTEM DOCUMENTATION - Design data used for the guidance of personnel who install, operate and maintain the system equipment shall be provided as part of the series of instruction manuals. Those manuals prepared to describe system level design shall meet the requirements of FAA-D-2494/1, which addresses Electronic Equipment Instruction Books. The system manuals shall include: Description, General Theory of Operation, and Detailed Theory of Operation.

a. For off-the-shelf equipment, the contractor shall deliver two copies of the standard commercial instruction book for interim use by the Government until the Final Instruction Book is printed. The commercial book delivered shall include the following information.

i Description of equipment

ii Theory of operation

iii Routine maintenance

iv Troubleshooting aids

v Parts list

vi Mechanical drawings or pictures as necesary to support the theory and maintenance sections

vii Schematic diagrams or logic diagrams

viii Wiring diagrams (including cabling)

ix Wire lists (when wire wrap is used)

x Firmware codings and flowcharts (when firmware is used)

3.5.2 HARDWARE DOCUMENTATION - Design data used for the guidance of the personnel who install, operate and maintain specific hardware units of the system equipment shall also be provided through a series of instruction manuals. Where new manuals must be prepared, they shall meet the requirements of FAA-D-2494/1. Standard manufacturers instruction books, such as those provided with standard production equipment and standard test equipment may be acceptable in meeting design data requirements. These standard instruction books would be acceptable if judged to be sufficiently complete so as to meet the information content specified in FAA-D-2494/1.

a. The contractor shall prepare a FDIO Equipment Instruction Manual in accordance with FAA-D-2494/1 and /2, and shall submit the manual to the Contracting Officer for approval in accordance with the contract schedule. The manual shall include sufficient level of details on the hardware and software and their interaction to enable thorough understanding of all FDIO function. The Manual's organization, content, and level of detail, shall be such that FDIO equipment problems, and problems concerning the interface with external systems and devices, are sufficiently treated to facilitate equipment troubleshooting.

b. The instruction book manuscript and/or instruction books to be provided shall be in accordance with FAA-D-2494/1 and /2, and as delineated in the contract schedule. Instruction Books must be judged acceptable by the Government and they must have blownup illustrations to show interelationship of hardware components, bits and pieces.

c. Engineering drawings shall be in accordance with DOD-D-1000B. Graphic symbols for digital logic diagrams shall be in accordance with FAA-STD-010c.

d. The contractor shall review the data obtained from the initial debug of the trouble-shooting sections of the equipment manuals as necessary to enhance their effectiveness. The contractor shall develop an equipment operations and maintenance manual down to the SRU level.

e. The contractor shall validate and provide for Government verification of manuals in accordance with FAA-D-2492/1 and /2. The manuals shall be used for the FDIO performance tests and during the acceptance of the first production items. Preliminary validation shall be completed prior to the maintainability demonstration. Final validation shall be completed prior to the training course.

f. APPENDIX IV contains "ATTACHMENT 2 excerpts" of the NAS documentation standards, here-in-after known as the "DEC-10 SYSTEM STANDARDS". Adherence to requirements of APPENDIX IV is required by the NAS Documentation Facility at the FAA Technical Center. This is an option item in the contract schedule.

MAGNETIC TAPE STANDARDS - Upon receipt of approval of the draft manuscript from the Contracting Officer, the contractor shall prepare a reproducible magnetic tape copy, with all corrections incorporated in accordance with the requirements of Specifications FAA-D-2494/1 and /2. Reproducible copy is text material on magnetic tape that can be entered by the NAS Documentation Facility (DEC 10) at FAA Technical Center and prepared for delivery. See APPENDIX IV for "INPUT TEXT AND COMPUTER LISTING TAPE STANDARD".

HARD COPY GRAPHICS STANDARDS - Reproducible (camera ready) graphics copy is an supporting copy for magetic tape text (line art, machine printouts, mechanical and electronic drawings, logic diagrams, flow-charts, photographs and negatives) that can be used as a hard copy input to the NAS Documentation facility (DEC 10) at the FAA Techincal Center. See APPENDIX IV for "INPUT HARD-COPY GRAPHICS and TEXT STANDARDS.

3.5.3 TEST DOCUMENTATION - All information concerning the testing of the FDIO System shall be provided as test documentation. This test documentation shall consist of test plans, test procedures, and test data sheets or test reports for all required tests. The requirements for test documentation shall apply to all levels of testing, such as system or unit, and to all locations of testing, such as factory or on-site. Test documentation shall conform to the requirements of FAA-STD-016 and all other contractual requirements. Test procedures shall be complete and in sufficient detail to permit evaluation of their adequacy in demonstrating compliance with specified performance requirements. In all test documentation, reference to specification requirements being tested shall be clearly indicated both by specification paragraph reference and by a brief descriptive title.

3.5.4 RMA DOCUMENTATION - The Reliability, Maintainability and Availability documentation requirements are specified in 3.7. The Reliability and Maintainability Demonstration documentation requirements are specified in 4.3.

3.5.5 INSTALLATION DOCUMENTATION - The contractor shall provide a Master Installation Plan, and Site Installation Plans. The contractor shall also provide As-Built drawings or as an alternative a mark up of FAA drawing shall be provided.

3.5.6 MAINTENANCE DOCUMENTATION - The contractor shall document the maintenance program in the document supplied to meet the requirements of 3.7.4.

3.5.7 FIRMWARE DOCUMENTATION

3.5.7.1 VENDOR MANUALS - The contractor shall provide copies of vendor documentation in accordance with the contract schedule. Included are programmers reference manuals, and documentation on software or firmware utilities used in the development of system firmware.

3.5.7.2 COMPUTER PROGRAM DESIGN DATA - The contractor shall produce and provide one reproducible and eight copies of all data required hereunder to be submitted for design review, including the items specified in the subparagraphs below, to the FAA Contract Office (CO) for review and approval as specified herein and as defined in the contract schedule. The design data submissions shall conform to the guidelines for content and format provided for FAA-SRDS-140-SDS-1: Software Documentation Standards for Program Development. They shall be organized to reflect the contractor's approach to the provision of the computer programs in accordance with specified requirements.

The submission of design data shall not be used to propose modifications or alternates to details of the software requirements or a change in scope of the contract. The design data referenced below shall include all computer programs to be produced by the contractor under the terms of the contract, as detailed by this specification and any addenda thereto. Paragraphs 3.5.7.2.1 through paragraphs 3.5.7.2.6 shall be used when tasked specifically by a contract schedule line item that utilizes a software function.

3.5.7.2.1. OPERATIONAL COMPUTER PROGRAM DESCRIPTION (OCPD) - The OCPD shall serve to identify, in general terms, the functions of the operational computer program including descriptions of system functional capability, equipment configurations and variations, each functional area, and each version and its implementation plan.

3.5.7.2.2. COMPUTER PROGRAM FUNCTIONAL SPECIFICATION (CPFS) - The CPFS shall specify, in minute detail, all the functions required of the computer program in order to satisfy system requirements. Included shall be detailed descriptions of those functions and their performance criteria, to be provided by the computer programs. Operational limitations, constraints or other qualifying data shall be included.

3.5.7.2.3. SOFTWARE INTERFACE CONTROL DOCUMENT (SICD) - The SICD shall describe computer program interface communications between all interacting systems or system components. The SICD shall provide detailed descriptions of the interface channels, hardware operation, startup/startover, interface order and control words, and data transfer.

3.5.7.2.4. PROGRAM DESIGN SPECIFICATION (PDS) - The PDS shall translate the functional specifications of the system into the resultant program design for that system. The PDS shall provide a description of system organization, message logic flow, program interfaces, and program storage and timing requirements.

3.5.7.2.5. SOFTWARE DESIGN DATA (SDD) - The SDD document shall describe all the program information on the internal design of the system. The SDD shall contain descriptions and logic flows of each program/routine of the subsystem, storage requirements and timing estimates, and program source listings.

3.5.7.2.6. DATA BASE TABLE DESIGN SPECIFICATION - The Data Base Table Design Specification shall include a detailed description of each table, including its functional dimensions, usage, lock requirements, ordering and general design considerations. The specification shall also include inter-table relationships, definition and layout, data descriptions, and any restrictions or limitations.

3.5.7.3 SYSTEMS USER'S MANUAL - The Users Manual provides the information needed to enable the user to control and operate each computer program. A complete list of terms and abbreviations used in the document shall be provided. Also, it shall provide a general program description plus description of the environment and use. A general description of progrm requirements and constraints shall be included, as appropriate. The User's Manual shall contain detailed description of:

(a) Input formats and devices

(b) Output formats and devices

(c) Control and diagnostic messages

(d) Options and their control

(e) Services request available

(f) Calling sequences

(g) Startup and startover procedures

3.5.7.4. FIRMWARE LISTINGS - The contractor shall provide commented, source code firmware listings for all programs.

3.6. INTERCHANGEABILITY - All items of off-the-shelf equipment shall be furnished at the same revision level of a particular model including information contained in all levels of instruction books.

Replacement parts, components, assemblies, subassemblies, PCBs, and modules shall be identical and at a common revision level and they shall be interchangeable. This information shall be contained in all levels of Instruction Books.

3.7. SYSTEM RELIABILITY AND MAINTAINABILITY - The contractor shall plan and implement reliability and maintainability programs to meet the detailed performance requirements of this specification. The reliability program shall be structured in accordance with MIL-STD-785B, except as modified herein. The replacement system shall be so designed and configured that in conjunction with the reliability requirements and the maintainability requirements the availability requirements will be met. The requirements as imposed in this section are not exclusively hardware oriented.

A remote group system is 3 RFSPs, 2 RANKs, 1CRT and 1 RCU. A central group system is 2 CCUs, 4 PCUs and 20 RFSPs. The aforementioned quantities of equipment constitute a FDIO System and they shall be used for all Reliability and Maintainability program tasks. A failure in anyone (SEE FIGURE 5 OR 7) of these units shall constitute a system failure.

3.7.1. GENERAL - The reliability, availability and maintainability definitions used in this specification are those of MIL-STD-721C, APPENDIX XI and paragraph 1.2.2.

(a) Component - An assembly or any combination of parts, subassemblies and assemblies mounted together, normally capable of independent operation.

(b) Module - A preassembled, organized group of parts complete in itself which is an element of a component and which can be removed and/or replaced as a single entity.

(c) Standard Parts - Standard parts are those parts delineated in FAA-G-2100c.

(d) Non-Standard - Non-standard parts are parts not delineated in FAA-G-2100c.

(e) Function Failure - A function failure is a failure that causes either the complete or partial loss of a functional capability.

(f) Equipment Failure - An equipment failure is a "black box", module, card, or part failure whose impact upon the system functions may vary from a minor maintenance action to catastrophic. An equipment failure is a relevant failure.

(g) System Failure - A system failure is a loss of service or any single point (relevant) failure.

3.7.2. NUMERICAL RELIABILITY, MAINTAINABILITY, AND AVAILABILITY REQUIREMENTS.

The system shall meet the following specified numerical requirements over the full range of environmental conditions specified in 3.2.3.1.

3.7.2.1. PREVENTIVE MAINTENANCE - Preventive maintenance on all FDIO elements shall be limited to cleaning, inspection, adjustments and replacement of parts in accordance with their service lives or as found necessary during inspection. This shall be limited to a maximum of the following times for each element:

(a) CCU: 30 minutes per quarter
(b) RCU: 30 minutes per quarter
(c) PCU: 30 minutes per quarter
(d) RANK: 90 minutes per quarter
(e) CRT: 90 minutes per quarter
(f) RFSP: 2 hours per quarter

3.7.2.2. BENCH REPAIR TIME - The mean bench repair time for any assembly, module, or printed circuit board shall not exceed four hours; and the maximum bench repair time shall not exceed six hours.

3.7.2.3 MEAN TIME BETWEEN FAILURES - The MTBF requirements for FDIO units are as follows:

(a)	CCU:	10,000 hours minimum
(b)	RCU:	10,000 hours minumum
(c)	PCU:	10,000 hours minimum
(d)	RANK:	10,000 hours minimum ✓
(e)	CRT:	10,000 hours minimum ✓
(f)	RFSP:	90 days of average usage where average usage is equal to 1,000 strips printed per day with all fields printed with a density of 40%. For this calculation enroute output strips shall be used. (1 1/3 inch vertical form). The print head life of a dot matrix printer shall have a minimum of 90 days of operational usage.

3.7.2.4. MAXIMUM TIME TO REPLACE (DISCONNECT AND CONNECT).

(a)	CCU:	15 minutes
(b)	RCU:	15 minutes
(c)	PCU	15 minutes
(d)	RANK:	5 minutes
(e)	CRT:	5 minutes
(f)	RFSP:	5 minutes

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3.7.2.5. MEAN TIME TO REPAIR (MTTR).

(a)	CCU:	30 minutes maximum
(b)	RCU:	30 minutes maximum
(c)	PCU:	30 minutes maximum
(d)	RANK:	30 minutes maximum
(e)	CRT:	30 minutes maximum
(f)	RFSP:	Mechanical Failures - 90 minutes maximum Electronic Failures - 30 minutes maximum

3.7.2.6. MAXIMUM REPAIR TIME (FOR 95% OF ALL REPAIRS).

(a)	CCU:	45 minutes maximum
(b)	RCU:	45 minutes maximum
(c)	PCU:	45 minutes maximum
(d)	RANK:	60 minutes maximum
(e)	CRT:	90 minutes maximum
(f)	RFSP:	3 hours maximum

3.7.2.7. MEAN TIME TO RESTORE - The MTR for a Remote Group or a Central Group shall be less than 30 minutes.

3.7.3. RELIABILITY PROGRAM - The contractor shall implement and maintain a reliability program in accordance with the following paragraphs.

3.7.3.1. RELIABILITY PROGRAM PLAN - The contractor shall submit for Government review and approval a reliability program plan in accordance with MIL-STD-785B. The reliability program plan shall be submitted in accordance with the contract schedule.

a. The contractor shall conduct a reliability plan in accordance with MIL-STD-785B, which covers TASKS 101, 104, 202 and 203 therein. The contractor shall meet the reliability requirements in paragraph 3.7.2.3 to the extent specified. A reliability program overview is delineated in APPENDIX A of MIL-STD-781C. The plan shall be documented per data item description DID DI-R-2113 in APPENDIX VII.

b. The contractor shall perform reliability tests in accordance with the MTBF tests of in Section 4.0. The FDIO performance parameters shall be recorded for each performance measurement. The unit failures and test data shall be recorded and analyzed and corrective action taken as delineated in paragraph 3.7.4.3.4. Operational time shall be accumulated for this requirement after satisfactory completion of the contractor's preliminary test prior to the tests for the Government. Failure data shall however, be recorded and analyzed from the start of the reliability test until acceptance of the first production unit by the Government.

The Reliability test procedures shall be done in accordance with DID DI-R-7035 in APPENDIX VIII.

c. When a unit of equipment has been rejected by the FAA Technical Officer, or Quality and Reliability Officer as a result of reliability test, each unit shall be reworked as necessary, reinspected, and another random unit sample drawn for another reliability test. In the event that the cause of the failure is faulty equipment, FDIO manufacturer design or part manufacturer design, corrective action shall be performed on all equipment delivered under the contract.

d. The contractor shall conduct a reliability assessment at the conclusion of the Reliability MTBF tests. This assessment shall be at the module/printed circuit board level.

e. Upon successful completion of reliability testing, tested equipments shall be returned to the production area for reinspection and reconditioning as required and shall be subjected to the test that remain, to assure that the requirements are met. After conditioning, reinspection, and retesting, the equipment shall be delivered as part of the contract quantity, provided it passes all subsequent tests.

3.7.3.2. RELIABILITY MANAGEMENT - The contractor shall have one clearly identified organizational element which will be responsible for the planning and management of the reliability program and for insuring its effective execution. The individual designated as head of this reliability management organization shall have the authority, resources and access to management necessary to enforce compliance with the reliability requirements of this specification.

a. The contractor shall be responsible for interfacing efforts in accordance with MIL-STD-785B.

3.7.3.3. RELIABILITY PROGRAM TASKS - The reliability program shall include all the task elements defined in 3.7.3.1. of MIL-STD-785B with the following tasks modified as indicated in the paragraphs that follow.

3.7.3.3.1. DESIGN REVIEWS - The reliability program shall include design reviews of the system; its function, hardware, firmware and specified performance requirements. These reviews shall be critical audits of the design to analytically demonstrate and assure compliance to the requirements of this specification. As a minimum, two reviews shall be held. They are preliminary design review and a critical (prior to design release to manufacturing) design review. Other reviews may be called as necessary either by the contractor or by the Government. All of the Tasks as enumerated in 3.7.3.3.2 through 3.7.3.3.4 shall be items covered in all design reviews with appropriate documentation as required by the contract schedule. The contractor shall address the factors in 3.3.2 for each element (RCU, PCU, CCU, CRT, RFSP and RANK) at each stage in the system design.

a. The contractor shall discuss the status of reliability program efforts and prepare a test procedures report for each of the reviews. This test procedures (optional in contract schedule) which shall also include reliability status and shall be documented in accordance with DID DI-R-2119 in APPENDIX V.

3.7.3.3.2. RELIABILITY/AVAILABILITY APPORTIONMENT - The reliability/availability requirements shall be apportioned to each of the components of the system. These apportionments shall show how the contractor intends to comply with the requirements of this specification. The apportionments shall be submitted at the first design review. Any changes in the apportionments shall be submitted to the Government for review and response. The approval or disapproval of any apportionment does not release the contractor from meeting the reliability/availability requirements of this specification.

a. The contractor shall prepare and submit the subject R & M AAA reports. The initial report, containing a complete detailed analysis of the equipment reliability and maintainability predictions, models, and a summary of the reliability program shall be submitted to the Contracting Officer in preliminary form after contract award within the time specified in the contract schedule. The Government will review the report and furnish comments to the contractor in the time specified in the contract schedule after receipt of the report. The report shall be updated to reflect the Government's comments and the final equipment configuration and shall be resubmitted with the reliability test procedure or the maintainability test procedure, whichever is submitted earlier. The final report shall include the assessment of the test results (both R and M tests). The R & M AAA report shall be per DID UDI-R-23570 in APPENDIX VI.

3.7.3.3.3. RELIABILITY ANALYSIS AND PREDICTION - The contractor shall provide a reliability prediction in accordance with the benign analysis method of MIL-HDBK-217D, except for the RFSP and RANK for which the contractor shall provide a preliminary analysis and prediction based on empirical test data, which demonstrates that these devices meet the requirements of 3.7.2.3. The empirical test data may or may not have been gathered in accordance with MIL-HDBK-217D, but if not, the contractor must include a full complete description of the test methods and results along with the preliminary analysis and prediction.

3.7.3.3.3.1. THERMAL DESIGN ANALYSIS - The contractor shall determine the thermal profile in any packaging configuration to be used. The design shall provide the means necessary to assure that all parts, components, and equipments, as they are used, are compatible with the environmental conditions of this specification.

3.7.3.3.4. PARTS AND MATERIAL CONTROL - The contractor shall establish a parts control task to ensure proper application of all parts. Parts Quality shall be in accordance with paragraph 3.8.2. Part applications in commercial equipment shall be within the parts ratings under all specified operational and storage conditions (SEE 3.2.3). Similarily, the deterioration rate shall be consistent with the MTBF requirements specified in 3.7.2.3 and shall be selected to minimize the replacement rates.

3.7.4. MAINTAINABILITY PROGRAM.

3.7.4.1. MAINTAINABILITY PROGRAM PLAN - The contractor shall submit for Government review and approval a maintainability program plan in accordance with MIL-STD-470 in its entirety, except as modified by this specification. The program plan shall include a Milestone chart including predictions, and maintainability demonstration. The maintainability program plan shall be submitted in accordance with contract schedule.

a. The contractor shall conduct a Government approved maintain ability program plan in accordance with MIL-STD-470 to the extent specified in this specification. The plan shall be issued per DID UDI-R-23558 in APPENDIX IX.

b. The contractor shall be responsible for interfacing efforts in accordance with MIL-STD-470.

c. The contractor shall direct his maintainability effort in consonance with the maintenance consideration set forth in the requirements of this specification.

3.7.4.2. MAINTAINABILITY MANAGEMENT - The contractor shall have one clearly identified organizational element which will be responsible for planning and managing the maintainability program. The individual designated as head of this maintainability organization shall have the authority and resources and access to management necessary to enforce compliance with the maintainability requirements of this specification. The maintainability organization may be part of the reliability organization as delineated in 3.7.3.2.

3.7.4.3. MAINTAINABILITY PROGRAM TASKS - The maintainability program shall include but not to be limited to the following tasks.

3.7.4.3.1. MAINTAINABILITY APPORTIONMENT - The systems availability requirements shall be allocated to establish detailed equipment maintainability requirements. These allocations should be in accordance with the reliability/availability requirements imposed upon the various positions and hardware items. These maintainability equipment position apportionments shall become the detailed equipment requirements. However, the contractor shall retain the necessary flexibility required to reallocate or trade-off of available parameters to meet system requirements. The maintainability apportionment shall be submitted in accordance with the contract schedule.

3.7.4.3.2. MAINTAINABILITY ANALYSIS AND PREDICTIONS - Maintainability analysis and preductions shall be performed for each element of the FDIO. Maintainability analysis shall be in accordance with 5.2 of MIL-STD-470. Predictions of mean corrective maintenance shall be performed in accordance with Procedure II, Part A, Corrective Maintenance, MIL-HDBK-472. The contractor is not required to perform empirical tests on Components, i.e., 3.2.1(c) of MIL-HDBK-472 does not apply. The Contrator may use manufacturer supplied data for all reliability and maintainability analysis. Preventive maintenance requirements shall be determined and the schedule, procedure, and the estimated duration of each preventive maintenance task shall be reported as part of the maintainability prediction results. The design shall optimize the realiability/ maintainability not only through the proper selection of parts, derating and redundancy but through adequate system partitioning to enable speedy location and replacement of failed items. Maintainability analysis and predictions shall be submitted in accordance with the contract schedule.

a. The contractor shall perform a maintainability analysis in accordance with MIL-STD-470. The quantitative and qualitative data obtained from this analysis shall be used as an input to other maintainability tasks such as allocation and prediction.

b. The contractor shall perform a maintainability prediction of the FDIO. The prediction shall be made to the subassembly level of complexity in accordance with MIL-HDBK-472 Procedure II, Part A, with normal distribution assumed. The data shall be used to determine the FDIO MTTR. The CRT and the CCU are also part of the model.

3.7.4.3.3. MAINTAINABILITY DEMONSTRATION - A maintainability demonstration of achievement of the specified mean and maximum corrective maintenance times and specified preventive maintenance times shall be performed as specified in 4.3 and the contract schedule. A Maintainability Demonstration Test Plan shall be submitted in accordance with the contract schedule. Specification Control Drawings (SCD) shall be used by the contractor to procure all nonstandard parts. Each SCD shall contin the manufacturer's part number, a JEDEC, RETMA, or equivalent part number or designation, failure rate, level of screening required, electrical characteristics, physical characteristics, performance parameters, and any other descriptive information as required by FAA-G-2100C. SCDs shall be submitted to the Government for review and response.

a. The contractor shall develop a maintainability demonstration plan in accordance with MIL-STD-471A with the exception of paragraphs 4.1.2.3., 4.1.2.4., 4.1.2.9., and section 4.1.3. The demonstration plan shall be considered an extension of Phase I as discussed in paragraph 4.1.2.2 of MIL-STD-471A. The contractor shall conduct a maintainability demonstration in accordance with the approved maintainability demonstration plan. The contractor shall measure and record time to repair on the FDIO from the start of module level testing to the end of equipment unit level testing. The M Demo Plan shall be documented per DID UDI-R-23564 in APPENDIX X.

b. The maintainability requirements shall be demonstrated by replacement of modules and chassis-mounted electronic, electrical, and electromechanical components and parts at the organization (site) maintenance level. A list of 100 faults shall be prepared for the equipment maintainability demonstration in accordance with APPENDIX B of MIL-STD-471A. The Government representative shall use this list as a guide to select a random part. Fault simulation for modules shall be accomplished by introduction of faulty part corresponding to the number selected. This part of the demonstration shall be conducted in a space environment (including clearances) similar to that in which the equipment will be installed. The emphasis shall be on the system restoration time rather than a specific equipment (i.e., RCU, CCU, etc.) MTTR.

c. The maintainability demonstration shall exhibit that the FDIO has met MTTR criteria prior to the delivery of the first FDIO.

d. The Government M-Demo participant will be a electronics technician who will be responsible for maintenance as defined in FAA-E-2552A. The contractor shall provide an equipment manual within the time specified in the contract schedule so the Government technician can review it prior to the M-Demo.

e. Technical documentation to be used for the maintainability demonstration shall be limited to the equipment technical manual.

f. If the Government representative determines that the contractor had failed the M-Demo, the Government contracting officer shall be immediately notified by the contractor.

g. The contractor shall identify hardware and firmware test points in the documentation to be reviewed prior to the M-Demo by the Government.

h. The contractor shall conduct a maintainability assessment at the conclusion of the maintainability tests.

3.7.4.3.3.1 MAINTAINABILITY DEMONSTRATION TEST LOG - A chronological test log shall be maintained throughout the maintainability test and shall provide the details of all significant events.

3.7.4.3.3.2. MAINTAINABILITY DEMONSTRATION TEST REPORT - A maintainability demonstration test report shall be submitted in accordance with the the contract schedule. This report shall document the results of the test. It shall provide the detailed calculations of the demonstrated maintainability. The report shall also include a copy of the maintainability demonstration test log.

3.7.4.3.4. FAILURE REPORTING, ANALYSIS AND CORRECTIVE ACTION - The contractor shall establish a closed loop system for reporting all failures. A closed loop system is one in which the contractor's program management office receives individual failure reports and assures that the appropriate Engineering, Reliability and Quality Assurance groups have performed the necessary analysis, repair and corrective action. The level of failure reporting within the equipment (e.g., circuit board, module, etc.) shall be delineated in the technical proposal. The reporting shall commence with the first application of power and continue through completion of testing. The failure report shall include all pertinent conditions concerning the failure occurrence, in sufficient detail to permit an adequate and conclusive failure analysis. It shall include, as a minimum, the following.

(a) Failure identification with date and time.

(b) Equipment involved, level of failure, i.e., component PCB etc., and operational mode.

(c) Environmental condition, type of operation or test and diagnosis time, and repair and checkout times.

(d) Failure analysis consistent with (b) above.

(e) Corrective action.

Failure data reports, including analysis results, shall be maintained by the contractor and shall be made available to the Government on request. The Government representative shall be notified of any failure within one working day of its occurence.

(f) The contractor shall include procedures for failure reporting, analysis, and corrective action included in the reliability program plan per Task 104 of MIL-STD-785B. The failure reporting system shall ensure that all failures which occur from the start of subassembly and assembly fabrication and test are recorded and reported to the procuring activity. Every failure shall be analyzed to determine if there is a failure or faulty mechanism which can be eliminated to prevent future failures. Corrective action shall be performed only to the extent allowed by commercial off-the-shelf vendors, suppliers, and subcontractors.

3.7.4.3.4.1. FAILURE SUMMARY REPORTS - Monthly summaries of failures shall be submitted during all phases of manufacture and test commencing with the preproduction model and all subsequent models. They shall include identification of each failure analysis report, the equipment failure mode and cause of failure, corrective action recommended, status of corrective action implementation, and relevancy (for reliability demonstration test failures). The summaries shall be so reported that trends, patterns, etc., can be discerned.

a. The final decision as to the relevancy of a failure shall be made by the Government using the failure categories of MIL-STD-781C and APPENDIX XI. Any operational discrepancy or degradation that requires an unscheduled adjustment under test, shall be specified as a relevant failure.

b. The contractor shall record any and all failures which occur during the FDIO unit testing in accordance with the failure reporting analysis, and corrective action requirements of the approved reliability program plan.

3.7.4.4. MAINTENANCE PHILOSOPHY/CONCEPT - The contractor shall develop and provide the provisioning data in accordance with FAA-G-1210d and the technical instruction books in accordance with FAA-D-2494/1a and 2a in consonance with the maintenance philosophy delineated below. If the option for training is exercised, this paragraph is also applicable to the extent specified in the contract schedule line item for Training. The FAA requires that restoration of failed FDIO's to the original specified condition shall be undertaken at the appropriate one of the following three (a,b, and c) levels of maintenance by FAA:

a. ON SITE/OPERATION AREA/REMOTE FACILITY LEVEL MAINTENANCE.

On site maintenance at the ARTCC or TRACON or ATCT operational area will be performed by personnel using equipment available at each site. Equipment maintenance at the ARTCC, TRACON, ATCT, and terminal facilities shall be facilitated by fault isolation to the LRU or module, using the built-in fault isolation capability such as diagnostics and indicators which preclude the need for special test equipment. Restoration shall be performed by removal and replacement of failed assemblies, PCBs, or modules. ~~Such restorations shall not require equipment to be readjusted. In place restoration of failed piece parts (e.g., wired in solder type) shall be unacceptable except for the back plan.~~ Mechanical components may require adjustments or the replacement of parts.

b. INTENTIONALLY LEFT BLANK (MOD 4)

b. INTERMEDIATE (MAINTENANCE HUB) LEVEL MAINTENANCE - Intermediate level maintenance of repairable failed equipment and piece part replacement within a module will be performed at the central/ARTCC maintenance area (the "HUB"). Such maintenance shall consist of all repairs that cannot be performed at the on-site ARTCC or Remote Facility operational area but can be performed within the capabilities of the personnel at the above applicable central/ARTCC maintenance area. The LRU's are repaired at this level of maintenance. The sites in ARTICLE I contract schedule ATTACHMENT 1 are the central maintenance areas/HUBs.

(mod 4)

c. TASK The depot accomplishes beyond The capabilities of the ON SITE/OPERATIONAL/ REMOTE FACILITY level MAINTENANCE level. Failed FDIO ASSEMBLIES, PCB's OR modules THAT are NOT repairable ON SITE will be REPAIRED OR overhauled AT depot. 3.7.5.

DEPOT LEVEL MAINTENANCE - The depot accomplishes tasks beyond the capabilities of the intermediate level. Failed FDIO assemblies, PCB's or modules that are not repairable at the ARTCC/HUB will be repaired or overhauled at the depot. Items whose repair and overhaul at the depot is not economically feasible, will be returned to the manufacturer or discarded.

BENCH REPAIR - If bench repair, (at the HUB or Depot) of failed assemblies, cards or modules requires special tools or equipment, these aids will be documented as prescribed in FAA-G-1210d entitled PROVISIONING TECHNICAL DOCUMENTATION.

SYSTEM MAINTENANCE PLAN - The contractor shall provide a systems maintenance plan which delineates all maintenance equipment, software, procedures, and personnel requirements for maintaining the system. As part of the design, interfaces shall be provided with the data processing equipment, and data entry and display equipment to aid in accomplishing the maintainability requirements and to be in consonance with the maintenance concept as delineated in 3.7.4 and the contract schedule.

The maintenance plan shall provide programs for performing periodic maintenance using centralization and automation. Manual techniques shall, to the extent possible, be minimized. The maintenance plan documentation shall be submitted in accordance with the contract schedule.

a. Maintenance is the action necessary for retaining the FDIO in or restoring it to an operational condition. Maintenance includes servicing, repair, removal and replacement, modification, inspection, calibration, overhaul, and negative condition verification. Corrective and preventive maintenance tasks are as defined in this verification. The contractor shall perform and verify preventive maintenance task times and corrective maintenance task times during the Maintainability Demonstration. The contractor shall delineate the preventive maintenance tasks and spare parts list in developing Instruction Books and Provisioning Data. Preventive maintenance tasks are permited during the tests.

3.8. MATERIALS, PROCESSES, AND PARTS

3.8.1. PARTS AVAILABILITY - The parts or material used shall be available in the United States of America. The bulk of the equipment shall be standard off-the-shelf units or sub-units and modules.

3.8.2. PARTS QUALITY - Selection of materials, processes, and parts shall be consistent with the requirement of producing a system that is not necessarily a completely MIL-Spec design type, but rather a system economically produced and capable of performing its specified functions with ruggedness and durability. Microelectronics, in equipment of new design that is not commercially off-the-shelf, shall use as a minimum ceramic components (SEE PARAGRAPH 3.7.3.3.4).

3.8.3. TOXICITY - The materials chosen shall be of low toxicity not having dangerous gases due to fire or toxic effects when used in a normal manner.

3.8.4. FUNGUS - The materials chosen shall be non-nutrient to fungus and insects, flame resistant, non-hydroscopic, and not adversely affected by the environmental conditions specified herein before.

3.8.5. USED PARTS - All parts and materials used in the equipment shall be new.

3.8.6. GLASS - All glass used in the equipment shall be shatterproof glass, and shall be clear and free of distortion of all viewing angles.

3.8.7. CABINETS - The equipment cabinets shall be constructed to maximize attenuation of electronic and magnetic field radiation outside the cabinet due to operating equipment inside the cabinets. The cabinets shall also be designed and constructed to maximize attenuation of electric and magnetic field radiation inside the cabinet due to the operating equipment outside the cabinets. EMI Control measures shall not increase electrical shock hazard to personnel from equipment cabinets and steps shall be taken to prevent shock hazard to personnel.

3.9. FINISHES - All equipment racks and cabinets shall be fully painted on all interior and exterior metal surfaces. Surface cleaning, priming and finish painting shall be in accordance with FAA-STD-012. All surfaces shall be prime painted in a neutral color. All exterior surfaces shall be finish painted.

Exterior metal surfaces of equipment cabinets and consoles, with the exception of front panels, shall be fully painted with color selected from FED-STD-595A. Painted cabinets supplied as part of standard commercial equipment do not have to be repainted just to change the color. Front panels of new design or modified equipment shall be painted with color selected from FED-STD-595A. Cabinet trim of brushed aluminum or stainless steel need not be painted. Work surfaces shall be covered with a hard plastic substance with a thickness of at least 0.04 inches (one millimeter). The Government will select the color within 90 days after contract award.

3.10 COOLING - All of the equipment shall use simple cooling techniques based on conduction, radiation, and free convection, using room air, to the maximum extent possible. Equipment requiring separate dedicated cooling systems shall not be used. Forced air cooling shall be used only when free air cooling is inadequate.

3.11 EMI ELECTRICAL DESIGN CONSIDERATIONS - All equipment shall be electrically constructed to minimize electric and magnetic field emissions and to minimize equipment susceptibility to electric and magnetic fields. The contractor shall locate and correct any operational deficiencies in equipment performance due to susceptibility of any unit of equipment to emissions from other units of equipment in the ARTCC. The contractor shall locate and correct any operational deficiencies in contractor provided equipment when the Government has determined that the contractor's equipment is responsible for an EMI problem in other NAS facility located equipment.

3.12 NAMEPLATES AND PRODUCT MARKING

(a) Nameplates shall include the manufacturer's name and contract number and shall be located in a conspicuous place, preferably on the back panel of the item.

(b) The plates shall not interfere with controls or obscure other information.

3.13 SAFETY - The design of all elements of the system shall provide protection against personal injury and equipment damage. System safety engineering principles shall be in accordance with MIL-E-4158, paragraph entitled "Safety of Personnel".

3.14 MONITORING - Monitoring of all replacement FDIO equipment shall be performed locally but will be aided by the autodiagnostic capabilities included in each element. Alarms or other indicators shall be provided to alert users to marginal or unsatisfactory performance.

3.15 CERTIFICATION - The methods provided by the system for obtaining the parameters necessary for certification shall be as automated as possible, however, manual operation of input devices and visual confirmation of output response shall be performed periodically. Preventive maintenance checks, performance checks and verification of standards and tolerances and will be performed during certification.

3.16 TRANSIENT PROTECTION AND GROUNDING - The design of FDIO equipment must provide for transient protection, lightining protection, grounding, bonding and shielding requirements as specified in FAA Standards 019 and 020. Theoretical considerations and design guidelines for effecting this protection are included in FAA Orders 6950.19 and 6950.20.

4. QUALITY ASSURANCE PROVISIONS

4.1 QUALITY CONTROL PROGRAM. - The contractor shall provide and maintain a quality control program in compliance with FAA-STD-016. The contractor shall prepare an Acceptance Test Plan which shall describe the hierarchy and philosophy of testing for the FDIO System. The Acceptance Test Plan shall clearly provide for tests at the equipment unit level, the equipment group level and at the system level. The Acceptance Test Plan shall clearly provide, as a minimum, for the testing as specified in this section. The Acceptance Test Plan and subsequent test procedures may be prepared in the contractor's format and may follow reasonable and customary procedures for a commercial computer grade system of this type; however, it shall be subject to FAA approval. As a part of the Acceptance Test Plan, and in correlation with the test hierarchy, the contractor shall provide and maintain a specification compliance schedule. This schedule shall clearly indicate, by specification paragraph reference and description of requirements, what test procedure will be used to demonstrate compliance with each requirement of the specification. As part of test planning, a list of tests shall be supplied with the preliminary design data. This list shall contain and identify all factory tests and inspections necessary to demonstrate compliance with the specified requirements. These tests shall be performed by the contractor and the contractor shall furnish all equipment, space and personnel required for their performance. Unless specified otherwise, the contractor's facilities shall be used or those of a commercial laboratory acceptable to the Government at the contractor's expense. Final acceptance tests for each group will occur after integration of that group to the NAS system. Post integration group tests and system level tests will be supported by the FAA due to physical and geographical factors.

4.1.1 GOVERNMENT INSPECTION - Unless otherwise specified, the tests and examinations to determine compliance with the electrical and mechanical requirements of section 3.0 shall be made by the contractor and shall be subject to Government inspection. The term "Government Inspection" as used means that an FAA representative will witness the contractor's testing and examinations and will carry out such visual and other inspections as deemed necessary to assure compliance with contract requirements. The Government reserves the right to waive Government inspection at the contractor's plant. If Government inspection is waived, the contractor shall furnish certified inspection records describing the readings or results obtained during the examinations and tests required in this section 4.0. The data must demonstrate that the equipment meets contract requirements, include the statement; "This certifies that this unit fully meets all technical requirements of the contract," and be dated and signed by a responsible official of the contractor. Shipment shall not be made until the contractor receives written Government approval of the equipment inspected, or the certified inspection records.

4.1.2 ACCEPTANCE TEST PLAN - The contractor shall submit after contract award, within the time specified in the contract schedule, a plan, for Government approval, which outlines the acceptance testing program required to demonstrate compliance of the FDIO subsystem with the requirements of the Contract. The plan shall include but not be limited to the following:

a. The plan shall provide an overview of all proposed test activities for all PCB's and equipment and for both the initial units and subsequent production units. Specific test activities shall be identified which comprise the contractor's Performance Tests within the meaning of FAA-G-2100c (except, on page 36, Table V, under Specification Requirement delete: "Electromagnetic Interference" and under paragraph Number delete: "3.3.2.6") and Paragraph 4.2. Site acceptance tests and conformance tests shall be performed in accordance with paragraphs 4.2.1 through 4.2.3. The overview shall clearly identify all test activities required to demonstrate compliance with all tests in section 4.0, list tentative start and completion dates, define the units and numbers of units involved in each test activity, describe the objectives of each test activity, and list the test documentation required.

b. For each test activity identified in a. above, the plan shall provide detailed requirements. The approved plan shall be used by the contractor as a basis for developing the equipment test procedures and data sheets.

c. A schedule showing the planned time periods for the performance of all test activities shall be included in the Acceptance Test Plan. This plan shall provide for completion of all test activities including factory acceptance tests and site acceptance tests within the time after contract award specified in the contract schedule.

d. The contractor shall provide an Implementation plan in accordance with DID DI-T-3737 in APPENDIX XII. This is an option item in the contract schedule.

4.1.3 EQUIPMENT TEST PROCEDURES - The contractor shall submit preliminary test procedures to the Government within the time specified in the contract schedule, and prior to each test activity defined by the approved test plan. The test procedures shall be comprehensive documents including all details necessary to assure that the test procedures and testing thereto will satisfactorily demonstrate equipment and system compliance with all functional, environmental, electrical, mechanical, reliability maintainability, output, and response time requirements as contained in section 3.0.

The Government will review the preliminary test procedures after receipt thereof and provide comments to the contractor within the time specified in the contract schedule. The contractor shall update the procedure, and resubmit in final form for Government approval within the time specified in the contract schedule and prior to test. Each test section of the test procedure shall reference the specified requirements of section 3.0 which are being verified by the test described in section 4.0.

For contractor-conducted acceptance tests, the contractor shall notify the Government in writing of test dates, at least as far in advance of the tests as the time specified in the contract schedule. The Government reserves the right to witness any and all tests and to require re-testing as may be needed to verify compliance with paragraph 4.2, and 4.3. Test procedures and data sheets shall comply with all requirements of FAA-STD-016.

The test procedures shall be documented in accordance with DID, UDI-T-23732B, in APPENDIX XIII.

4.1.3.1 PCB TEST PROCEDURES - The contractor shall provide test procedures for fault isolation on the printed circuit board assembles and documented as stipulated in 4.1.3 above.

(mod 4) OFF-THE SHELF ITEMS ARE EXCLUDED TO THE EXTENT THAT VENDOR MANUALS

4.1.4 INSPECTIONS - The contractor shall perform all inspections ADEQUATELY ADDRE required in Section 4 herein. The contractor shall use his THE TEST PROCED own or any other facilities suitable for the performance of the inspections unless disapproved by the Government. The Government reserves the right to witness any of the inspections conducted, to audit any of the contractor's procedures and methods, and to perform any of the inspections where such inspections are deemed necessary to assure supplies and services conform to requirements of Section 3.

4.1.5 QUALITY CONFORMANCE INSPECTION - Production inspection shall be made on each equipment offered for delivery. The inspection shall comprise such examinations and testing that will prove workmanship and reveal degradation and errors of the production process. Functional and performance tests shall be made to verify the following: tests to detect deviation from design, tests of adjust-ments, and test to detect hidden material defects shall be accomplished. This inspection shall include but not be limited to the factory acceptance tests in paragraph 4.2.

4.1.6 TESTS AND DEMONSTRATIONS - The contractor shall conduct the unit (paragraphs 4.2.4 to 4.2.9) tests, acceptance tests and other tests demonstrations to verify conformance with the performance and testing requirements to this contract. The contractor shall develop these test procedures as delineated in paragraph 4.1.3.

4.1.6.1 PERFORMANCE MEASUREMENT DURING TEST - The contractor shall perform during the test, operational test of equipment controls and measurements of functional parameters that are of sufficient duration or repeated at appropriate intervals to ensure confidence of control operation and performance characteristics.

4.1.6.2 FAILURE CRITERIA - Deterioration, corrosion, changes of tolerance limits of any internal or external parts, or deviations from recorded performance data beyond allowed limits which in any manner could prevent the equipment from complying with operational service or maintenance requirements shall provide reason to consider the test item as having failed to withstand the conditions of test. (i.e., leakage or discoloration of impregnating compounds shall be considered damage and cause for rejection.) Also see APPENDIX XI for additional failure criteria.

4.1.7 TEST REPORTS - The contractor shall prepare test reports for each site and for each classification per section 4.3. These test reports shall be prepared in accordance with the requirements for "test data" in FAA-STD-016 and documented in accordance with DID, UDI-T-22741A in APPENDIX XIV. These reports shall be submitted to the Government for approval. This includes the information required in paragraph 4.3.4.

4.1.7.1 FINAL TEST REPORTS - Upon completing each test defined by the approved test plan the results shall be recorded and submitted to the FAA. The test report shall contain a complete description of the test results and be documented in accordance with DID, UDI-T-22741A in APPENDIX XIV. The test report shall contain, as a minimum, the information specified below:

a. Copies of the test data sheets.

b. The performance of each equipment under test and whether it meets the system limits.

c. Functions that were tested.

d. Information as to whether the results of the test are in agreement with the required reliability and maintainability characteristics.

e. A record of any engineering changes found necessary to correct design deficiencies.

f. Copies of all discrepancies noted during the test, with the Government accepted disposition.

g. Copy of all deviations from the approved test procedures required during conduct of testing.

h. Inclusion of the R&M AAA report and failure reports.

4.1.8 INTERFACE INPUT SIMULATION - The equipment and data source (hardware and software) required to simulate the IBM 9020 adapters, interfaces and signals shall be provided by the contractor for all tests up through factory acceptance test at the contractor test location. The tests required by paragraphs 4.2 and 4.3 shall not begin until the simulation equipment and data source is available. After completion of contract, the simulation equipment and data source shall be delivered as part of the Test Bed Contract schedule line item.

4.1.9 RECONDITIONING OF TESTED EQUIPMENT - Equipment which has been subjected to initial inspection testing shall be reconditioned by the contractor. This shall include replacement of all worn or damaged items.

4.2 PERFORMANCE TESTS - The performance tests shall be designed to demonstrate the performance requirements given in 3.2 and 3.4. They shall, in their hierarchical design, demonstrate from the unit level to the system level. The test procedures shall list all test equipment and special jigs/fixtures required. The test equipment used shall be identified by make and model, and calibration limits stated. The test procedures shall have detailed step-by-step instructions with a concise but comprehensive explanation of the test, including test scenario, and objective. Equipment interconnection shall be explicitly described in graphical and textual form. All formal tests shall be peformed using firmware. Factory acceptance tests (FAT) for the Remote Groups and Central Groups shall have type tests and production tests as delineated in FAA-G-2100c to the extent specified in paragraphs 4.2.2 and 4.2.3. Site acceptance tests (SAT) are as delineated in paragraph 4.2.1 and to the extent specified in the contract schedule turnkey requirements.

4.2.1 SYSTEM TESTS - Test procedures shall be provided to demonstrate that the FDIO System meets the requirements of 3.2.1.1. System level tests must verify that all subordinate elements perform their required functions when integrated into the FDIO system. These procedures shall be applied at the ARTCC level and shall be repeated for each ARTCC, its Central group and the associated Remote groups. It is the responsi-bility of the contractor to coordinate these tests; however, it will be necessary for FAA personnel to participate.

4.2.2 REMOTE GROUPS - Test procedures shall be provided to demonstrate that each married Remote group meets the performance requirements of 3.2.1.2. These procedures shall be performed ~~twice, once at the contractor's facility~~ and once after each group is integrated at the site. It is the contractor's responsibility to coordinate testing between Remote groups and integrated Central groups.

(mod 20)

4.2.3 CENTRAL GROUPS - Test procedures shall be provided to demonstrate that each married Central group meets the performance requirements of 3.2.1.3. These procedures shll be performed ~~twice, once at the contractor's facility and~~ once after each group is integrated at the site. It is the contractor's responsibility to coordinate testing between Remote groups and integrated Central groups.

(mod 20)

4.2.4 CENTRAL CONTROL UNIT - Test procedures shall be provided to demonstrate that the CCU meets the performance requirements of 3.4.1.1.

4.2.5 REMOTE CONTROL UNIT - Test procedures shall be provided to demonstrate that the RCU meets the performance requirements of 3.4.1.2.

4.2.6 PRINTER CONTROL UNIT - Test procedures shall be provided to demonstrate that the PCU meets the performance requirements of 3.4.1.3.

Factory Acceptance Tests shall be accomplished at the unit level. Test beds shall be established to test Central Control Units (CCU), Remote Control Units (RCU), Printer Control Units (PCU) and Peripheral Units, i.e. Replacement Flight Strip Printers, Replacement Alphanumeric Keyboards and CRTs. The test beds shall consist of:

CU Test Bed - 1 RCU, 8 RFSPs, 3 CRTs, 3 RANKs, 1 NASSIM, (RCU to test each individual slot in the CCU)

PCU Test Bed - 28 RFSPs, 1 NASSIM ← 4.2 eighth sentence (Mod 20)

RCU Test Bed - 1 CCU, 8 RFSPs, 3 CRTs, 3 RANKs, 1 NASSIM

Peripheral Test Bed - 1 P/C with RS232/422 capabilities.

Unit Factory Tests shall be conducted in accordance with Unit Factory Acceptance Test Procedures, Volume VIII, Sections A-F.

4.3.1 CORRECTIVE MAINTENANCE TESTS - The contractor shall perform the corrective maintenance demonstration in accordance with MIL-STD-471A, except as modified in this paragraph. The task selections shall be as stated in APPENDIX B of MIL-STD-471A. The statistical corrective maintenance tasks shall have failure modes statistically chosen. Test Method 1B, of MIL-STD-471A shall be used for all corrective maintenance tasks for all of the positions listed in the reliability and maintain-ability section of this specification. The contractor shall submit 100 sample corrective maintenance tasks in accordance with APPENDIX B of MIL-STD-471A on the system as a whole. The Government will randomly select 50 of these tasks for the statistical corrective maintenance demonstration test.

From this set of corrective maintenance tasks, and any other corrective maintenance tasks chosen by the Government, the Government will select 20 tasks for the non-statistical corrective maintenance demonstration. The statistical corrective maintenance demonstration mean down time, and the non-statistical corrective maintenance demonstration mean down time, shall not be greater than the specified mean time to repair specified in 3.7.2. During both the statistical corrective maintenance demonstration and the non-statistcal corrective maintenance demonstration, any real equipment failure shall be corrected. Such a failure shall be timed and counted as one of the sample corrective maintenance tasks for the corrective maintenance demonstration in progress at that time. The maintainability demonstration test step in progress shall be considered a failure (simulated or real) if it causes any portion of the system not to meet the performance requirements of this specification, regardless of the outcome of the maintenance demonstration activity. Section 4.4 of MIL-STD-471A shall be omitted for the purpose of this specification.

4.3.1.1 REMOTE GROUP - Test procedures shall be provided to demonstrate that the Remote group meets the MTR specified in 3.7.2.7.

4.3.1.2 CENTERAL GROUP - Test procedures shall be provided to demonstrate that the Central group meets the MTR specified in 3.7.2.7.

4.3.1.3 CENTRAL CONTROL UNIT - Test procedures shall be provided to demonstrate that the CCU meets the MTTR specified in 3.7.2.5.

4.3.1.4 REMOTE CONTROL UNIT - Test procedures shall be provided to demonstrate that the RCU meets the MTTR specified in 3.7.2.5.

4.3.1.5 PRINTER CONTROL UNIT - Test procedures shall be provided to demonstrate that the PCU meets the MTTR specified in 3.7.2.5.

4.3.1.6 REPLACEMENT FLIGHT STRIP PRINTER - Test procedures shall be provided to demonstrate that the RFSP meets the MTTR specified in 3.7.2.5.

4.3.1.7 REPLACEMENT ALPHA-NUMERIC KEYBOARD - Test procedures shall be provided to demonstrate that the RANK meets the MTTR specified in 3.7.2.5.

4.3.1.8 CRT DISPLAY - Test procedures shall be provided to demonstrate that the CRT display meets the MTTR specified in 3.7.2.5.

4.3.2 PREVENTIVE MAINTENANCE TESTS - The contractor shall perform the preventive maintenance demonstration in accordance with Government approved plans and procedures. The Government will select any number of preventive maintenance tasks which are contained in the approved procedures which shall be performed during the preventive maintenance demonstration tests. The total number of tasks shall be the same as those contained in the instruction manuals. The procedures shall also list the recommended frequency at which the tasks are to be performed, and the time required to perform these tasks. Equipment required for operational (on-line) use shall not be preempted for preventive maintenance.

4.3.2.1 REMOTE GROUP - Test procedures are required for the preventive maintenance test for a Remote group.

4.3.2.2 CENTRAL GROUP - Test procedures are required for preventive maintenance test for a Centerl group.

4.3.3 MEAN TIME BETWEEN FAILURE TESTS - The MTBF tests shall demonstrate compliance with the requirements of 3.7.2.3. MTBF test procedures are required for each unit and group. As stated in 4.1 the Test Plan and procedures are subject to Government approval.

4.3.3.1 CENTRAL CONTROL UNIT - Test procedures shall be required to demonstrate the MTBF for the central control unit. Because the MTBF figures in 3.7.2.3 are high, it is anticipated that empirical data gathering would require excessive testing periods. The contractor may choose for the CCU to calculate reliability using paragraph 5.2 Parts Count Reliability Prediction of MIL-HDBK-217D. Use of the Parts Count Reliability Prediction Method of MIL-HDBK-217D as required by paragraph 3.7.3.3.3 will not relieve the contractor from recording and reporting, in accordance with the procedures contained herein, all failures within the CCU that occur during other phases of testing/demonstration except for the first 50 hours of powered operation.

4.3.3.2 REMOTE CONTROL UNIT - The MTBF test requirements for the RCU shall be the same as for the CCU, per 4.3.3.1.

4.3.3.3 PRINTER CONTROL UNIT - The MTBF test requirements for the PCU shall be the same as for the CCU, per 4.3.3.1.

4.3.3.4 REPLACEMENT FLIGHT STRIP PRINTER - Test procedures will be required to demonstrate the MTBF requirements specified in 3.7.2.3. For the RFSP, this procedure shall be completed for each RFSP of the first 10 RFSP's supplied by the contractor. After the first 10 units, the procedure shall be performed on RFSP's designated by the Government, not to exceed 5 RFSP's per 100 supplied.

4.3.3.5 REPLACEMENT ALPHA-NUMERIC KEYBOARD - The MTBF test requirements for the RANK shall be the same as for the CCU, per 4.3.3.1.

4.3.3.6 CRT DISPLAY - The MTBF test requirements for the CRT display shall be the same as for the CCU, per 4.3.3.1.

4.3.4 TEST LOG - A chronological test log shall be maintained throughout the reliability and maintainability demonstration tests. This log shall provide the dates and times of all significant events. A list of events which must be recorded is specified in items a. through e.

a. Power on and off times of each equipment of equipment group.

b. Start and stop times of demonstration testing.

c. Functions, modes, and phases of tests, including random tests.

d. All interruptions of test, including all failure details.

e. Any unusual conditions in equipment under test, auxiliary equipment, source power or enviornment.

4.4 TEST EQUIPMENT - All test equipment required for use during tests conducted at the factory or approved laboratory or test facility shall be provided by the contractor or subcontractor. During tests conducted on site, the contractor shall be responsible for assuring that all necessary test equipment is available, on time, properly calibrated and fully operational to support all tests. All test equipment used during the Factory or Site Tests shall be standard commercial equipment and shall not be modified. The test equipment shall operate in the manner specified by the test equipment manufacturer. Use of custom test equipment or modified commercial test equipment requires approval in writing by the Government. All ancillary equipment required for testing shall be furnished by the contractor for the duration of the tests. The Government may require the contractor to recalibrate any test equipment provided by the contractor to be used in the test program, due to the following:

a. The test equipment is removed from the test setup for unrelated purposes.

b. The test equipment fails or is damaged, or appears to be operating in a faulty manner based on Government evaluation of test results.

4.5 RETEST - Failure of the FDIO equipment to meet specified requirements shall cause the contractor to determine the reason for the non-compliance, and the contractor shall be responsible for all corrective action necessary to assure full specification compliance. The contractor shall complete all repair or rework prior to submission for retest. The Government will determine the extent of retest required. No retest shall be commenced until the contractor has submitted in writing all information concerning the non-compliance and the corrective action taken, and the Government agrees to start the retest. If a review of the reasons for failure to comply with specification requirements indicates that the cause may exist as latent defects in items previously accepted, the contractor shall be responsible to correct the defects in all units, in a timely manner, even those previously accepted by the Government.

4.6 STANDARD SITE PREPARATION EFFORTS - The various FDIO sites are of slightly different configurations and contain different quantities and varieties of equipment and facilities. The contractor shall conduct a survey of all turnkey sites in advance of equipment delivery, to become familiar with the different environments that will be encountered during installation and verification test of the FDIO subsystem. Potential installation and testing problems should be uncovered during the contractor's survey of the sites. These site surveys shall be the basis for preparation of the Standard Site Preparation Report as described below. In no case shall any claim by the contractor be placed against the Government arising out of differing site environments.

4.6.1 SITE INSPECTION AND SURVEY - The facilities to be visited shall be all turnkey sites in this contract contract schedule ARTICLE I ATTACHMENTS 1 through 8 nine months prior to the hardware delivery.

Government representation will be available during these site surveys, and access to equipment room as well as other FDIO associated areas will be provided by the Government. The Government will furnish the date of readiness for site survey. A copy of drawings covering floor plan layouts, AC power, duct or overhead ladder installations of the equipment rooms and FDIO associated areas shall be made available for reviewing to the contractor during these inspections. The Government makes no guarantee that the drawings are error free or that they contain all the information needed. The objective of these on-site inspections is to provide the contractor with an opportunity to gather first-hand information to be used in the preparation of his Standard Site Preparation Report.

4.6.2 REPORT CONTENT - The contractor shall prepare a Standard Site Preparation Report and submit it to the Technical Officer covering all sites surveyed. This report shall be applicable to the installation and test of the FDIO system(s) to be installed at Turnkey sites. The report shall include, as a minimum, the following:

MOD 4

a. ~~Typical~~ Specific floor plan equipment layout and maintenance area.

b. List of typical FDIO equipment.

c. Tabulation of physical and electrial power characteristics for each equipment unit type (i.e., overall dimensions, uncrated weight, cabinet, and unit prime AC power, voltage, maximum operating KVA, power factor, BTU/hour heat load generated, and turn-on in-rush line current). Identification of electrical power requirements that the contractor shall provide for each sites to connect the system to the Government provided power distribution panel.

d. List of ~~typical~~ Specific FDIO Equipment interconnection and interface cables, cable access points, cable routing, etc.

e. ~~Typical~~ Specific procedures concerning off loading, unpacking, placement of equipment, test requirements, wiring diagrams and cable lengths, etc.

f. Special test equipment to be furnished by contractor.

g. Standard test equipment that is to be provided by the contractor per paragraph 4.4 at each site for use by the contractor on-site personnel.

h. ~~Typical~~ Specific scheduling requirements and test and implementation plans.

i. Administrative support facilities required for contractor on-site personnel.

4.6.3 Government Furnished Information For Each Installation Site
The Government will furnish the following Site Preparation information to the contractor as required:

a. Existing floor plan of the FDIO area showing available space, power source, adjacent equipment, etc.

b. Site adaptation data for use by the contractor in preparing the assembled operational and nonoperational site adaptation data.

c. Any other site information pertinent to the FDIO subsystem installation (e.g., any local electrical grounding, protection requirements).

d. Notwithstanding the above, the Government makes no guarantee that the information provided is error free or is all the information needed to achieve FDIO subsystem installation.

e. Date of readiness for site survey.

4.7 INSTALLATION AND VERIFICATION TEST - (Turnkey System(s) Only.) The contractor shall install, de-bug, and test the FDIO system(s) at all facilities designated turnkey in accordance with the Contract Schedule and this Specification. Installation and verification tests shall proceed in accordance with approved Installation Documents. While installation and verification test are performed in an ARTCC, TRACON, Tower, and terminal facilities, the FDIO interfaces will be available on a limited daily basis, the timing of such availability will be subject to operational requirements at each site. Therefore, adjustment of the contractor installation team working hours shall be required to prevent conflicts with Air Traffic Control operations. The contractor shall schedule and perform work in such a manner so as to not disrupt the normal operations of the installation site. It shall be the responsibility of the contractor to meet the requirements of this 4.7 and to provide a functional equipment/system. Any feature or item necessary for proper equipment/system operation, in accordance with the requirements herein shall be incorporated even though the item or feature may not be specifically described herein. Verification for non-turnkey system(s) shall be performed at the contractor's facilities.

4.7.1 EQUIPMENT INSTALLATION AND TEST - The contractor shall install and test each FDIO system(s) at the sites specified as Turnkey. FDIO installation and test shall be accomplished prior to the Government's acceptance of the FDIO. For each FDIO system(s), the installation and test shall begin immediately following delivery to the site.

4.7.2 GROUND TERMINATION - The contractor shall connect the FDIO equipment grounds to the Government furnished ground terminations. The contractor shall be fully responsible for interfacing his equipment grounding system with that of the facility as identified and approved in the installation planning report (site preparation report).

4.7.3 CONTROL AND DATA SIGNAL CABLES - All control and data signal cable and connectors within the FDIO system(s) and between the FDIO system(s) and external equipment shall be furnished and installed by the contractor at the installation site. The contractor shall install and test the intra-system and inter-system cabling terminations, associated FDIO system(s) grounding interfaces, and connections with external grounding facilities at the site.

4.7.4 MECHANICAL INSTALLATION - The contractor shall be responsible for all installation aspects for the entire FDIO system except as specifically excluded herein. The Government will coordinate and provide liaison during the installation of FDIO system(s) within each site.

4.7.5 ELECTRICAL INSTALLATION AND TEST - The contractor shall furnish all FDIO cabling, wiring, connectors, and associated hardware for making all cable and wire terminations at all sites from FDIO system to the appropriate points (including existing hardware, telephone lines, and FAA power distribution panels). This requirement includes electrical cabling and connectors for all special test equipment provided by the contractor. For non-turnkey systems, the above two sentences in this paragraph are also applicable to the contractor. The contractor shall utilize the site survey results as a baseline for furnishing the above.

4.7.6 INSPECTION AND IDENTIFICATION OF DEFICIENCIES - If requested by the contractor, the contractor will be given access to any or all of the facilities in which FDIO system(s) is to be installed by the contractor for the purpose of making measurements of the electromagnetic radiation environment at those facilities. The Government does not guarantee that all facilities will have the same electromagnetic environment nor does it guarantee that all facilities of the same type (e.g., Air Route Traffic Control Centers) will have the same environment. Should any case arise in which it appears to the Government that interference exists, the contractor shall, within sixty days after the receipt of written notice by the Contracting Officer, demonstrate conclusively and to the satisfaction of the Government by means of tests, data or other appropriate means deemed acceptable to the Government (a) the identification of the source of the interference and (b) the corrective action the contractor determined to be needed to eliminate the interference if found in the FDIO system(s) or the corrective action that the contractor determined to be needed to eliminate the interference to the FDIO system(s), if the source is found to be external to the FDIO system(s). Also see paragraph 3.11. In no case shall any claim by the contractor be placed against the Government for tests related to the identification of the source or the corrective action taken to eliminate the interference as a result of this requirement.

4.7.7 CONSTRAINTS - En Route Air Traffic Control Centers (ARTCC's), TRACON's, ATCT's, and terminal facilities at which installation, integration, and support activities shall be conducted have an on-going air traffic control (ATC) function. The contractor shall not interfere with the live Air Traffic Control environment function.

The contractor shall make adequate provisions in his personnel staffing and procedures to allow for flexible utilization and schedules of his on-site personnel to avoid conflicts with FAA activities at the site. The government will make every effort to permit as much of the installation and testing work as possible to proceed on the prime shift for simultaneous operation at the terminal and ARTCC locations. The prime shift is from 8 a.m. to 10 p.m. daily. However, no assurance can be given that prime shift time can be made available to the contractor. All wiring, materials, and procedures used during installation and testing shall be in conformance with all local codes and the National Electrical Safety Code, and when in conflict the local code shall have precedence.

4.7.8 LETTER OF NOTIFICATION - The contractor shall submit a letter of notification to each site with a courtesy copy to the Contracting Officer at least 30 calendar days prior to each equipment group delivery. This letter shall state the anticipated delivery date date of the equipment and material, the arrival date(s) of contractor personnel, the identification of the contractor personnel personnel and any other information pertinent to the FDIO installation. Upon request from the contractor, the Contracting Officer will (mod 4) Provide ~~privde~~ the names and addresses for the facility representative prior to the start of installation and testing of Turnkey systems.

5. PREPARATION FOR DELIVERY

5.1 DIRECT SHIPMENT TO A SITE - Shipment of material from the contractor's plant to a specific site shall be the contractor's responsibility. The contractor shall be responsible for transportation and for moving all deliverable equipment, cables, and materials to their installation sites and positions within the buildings.

5.1.1 SMALL COMPONENT MATERIAL - Small individual items or components shall be packed and marked both internally and on the exterior surface of the containers. If the unit is serialized, this identification shall also appear on the exterior surface on the container.

5.2 MATERIAL FOR INVENTORY STORAGE - Material (Depot spares and spare parts peculiar) being delivered for inventory storage shall be packed in accordance with the requirements of the contract schedule.

5.3 PACKING OF SYSTEM OR SUBSYSTEMS FOR STORAGE - Systems or subsystems and site spares to be placed in storage at a Government facility shall be packed in accordance with the contract schedule.

6. NOTES

6.1 NOTE ON INFORMATION ITEMS - The contents of this section are only for the information of the procurement request and are not a part of the requirements of this specification. They are not contract requirements nor binding on either the Government or the contractor. In order for these terms to become a part of the resulting contract, they must be specifically incorporated in the schedule of the contract. Any reliance placed by the contractor on the information in these subparagraphs is wholly at the contractor's risk.

6.2 PARTS COUNT RELIABILITY PREDICTION - The parts Count Reliability Prediction method of MIL-HDBK-217D is a method for MTBF determination. The environment is chosen for 25 degrees centergrade ambient temperature and 10 degrees centergrade in bay tolerance.

6.3 COMMUNICATIONS STANDARDIZATION - Transfer of FDIO data in telecommunication circuits shall be in accordance with FAA Order 1830.2, Policy for Use of Telecommunications Data Transfer Standards. This order, when combined with the requirements of the FDIO Replacement Specification, imposes standards which inlcude, but are not limited to the following:

a. Communication Code - International Alphabet No. 5 (IA-5), International Version, as defined in Federal Information Processing Standard Publication (FIPS PUB) 1.

b. Signalling Rates - Selected from among 110, 150, 300, 600, 1200, 2400, 4800, and 9600 bits per second (b/s).

c. Transmission Mode - Asynchronous transimission below 1200 b/s; synchronous transmission above 1200 b/s; either transmission mode at 1200 b/s.

d. Bit Sequencing - The low order bit transmitted first, as defined in FIPS PUB 16.

e. Character Structure and Parity Sense - AS defined in FIPS PUB 17.

f. Electrical Characteristics and Modulation Requirements:

(1) Electrical interfaces shall comply with Federal Standard 1031, which adopts Electronic Industries Association (EIA) Standard RS-449.

(2) Modems operating at 2400 b/s shall conform to the requirements of Federal Standard 1005.

6.4 ERROR CHECKING - Means shall be provided for detecting errors which may occur during the transfer of data among all elements of the FDIO system.

6.5 DATA ITEM DESCRIPTION (DID) - The applicable portion of the DATA Item Descriptions (DID's), in Appendices III through XIV, except Appendices IV and XI, to be used is the contents in block/section 10.0. Wherein there is reference to a DOD agency, "FAA" shall be subsitituted in place of th DOD agency referenced.

APPENDIX I

10. CCU-RCU INTERFACE CONTROL DOCUMENT

10.1 SECTION 1, INTRODUCTION

10.1.1 PURPOSE - The information contained herein describes the interface control requirements for communications links between the Central Control Unit (CCU) and the Remote Control Units (RCU's) in the FDIO system. These procedures have been developed to be applicable if NADIN concentrators functionally replace the CCU's.

10.1.2 SCOPE - This Appendix addresses interface control requirements at three levels:

a. Physical, i.e., the communications lines, modems, and the electrical/mechanical connections;

b. Link control, i.e., the control of transmission; and

c. Message, i.e., the content of actual data transmitted.

10.1.3 SYSTEM OVERVIEW - Remote terminal to computer communications in the FDIO system involves three (two-way) interfaces:

a. Terminals to RCU;

b. RCU to CCU (or NADIN concentrator); and

c. CCU to NAS 9020 computer.

Only the second of these is explicitly addressed by this Appendix. The CCU and PCU to NAS 9020 computer interfaces are specified in APPENDIX II. The terminal to RCU interface shall be defined by the contractor as part of his software documentation submissions.

All output messages from the computer to the remote terminals (printers) are transmitted to the CCU. The CCU buffers the messages, implements the data link control procedures (protocol), and transmits the messages to the appropriate RCU's. Each RCU determines the acceptability of the messages received, implements exception recovery (if pertinent), buffers acceptable messages, and forwards them to the appropriate terminals.

All input messages from remote terminals (keyboards) to the computer are composed and edited through logic in the associated RCU's. When messages are ready for transmission, the RCU's buffer them, implement the data link control procedures, and transmit the messages to the CCU. The CCU determines the acceptability of messages received, implements exception recovery (if pertinent), buffers acceptable messages, and transmits them to the computer.

10.1.4 REFERENCES

a. FAA Order 1830.2, February 17, 1978, "Policy for Use of Telecommunications Data Transfer Standards."

b. EIA Standard RS-449, November 1977, "General Purpose 37-Position and 9-Position Interface for Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data."

c. ANSI X3.66-1979, January 9, 1979, "American National Standard for Advanced Data Communication Control Procedures (ADCCP)."

d. ANSI X.3.4-1968, "The American National Standard Code for Information Interchange," (FIPS PUB 1).

e. FAA Specification FAA-E2661a, November 5, 1982, "National Airspace Data Interchange Network (NADIN)."

f. EIA Standard RS-366-A-79, March 1979," Interface Between Data Terminal Equipment and Automatic Calling Equipment for Data Communication."

g. EIA Standard RS-422, April 1975, "Electrical Characteristics of Balanced Voltage Digital Interface Circuits."

h. Federal Standard 1005, Janaury 20, 1977, "Telecommunications: Coding and Modulation Requirements for Nondiversity 2400 bit/second Modems."

i. Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange -EIA Standard RS-232C, August 1969.

j. ICAO Annex 10 VOLUME I and VOLUME II.

10.2 SECTION 2, PHYSICAL CONTROL LEVEL - Telephone lines and modems will be leased or procured independently of the FDIO System. However, the characteristics of this equipment are described in this section. FDIO hardware shall function and interface properly with the lines and modems described herein.

10.2.1 COMMUNICATIONS LINES

10.2.1.1 PRIMARY LINKS - The primary communications lines shall be 4-wire, voice grade, non-switched leased lines. Each CCU shall have 28 ports to accommodate such circuits, each of which may be either multipoint or point-to-point configurations. However, some of these ports may be used for back-up circuits, as described below.

10.2.1.2 BACK-UP LINKS - Each remote installation shall be provided with a dial back-up capability for use in the event of leased line outage. This capability may be automatic or manual. This back-up service shall use 2-wire, voice grade, switched lines.

Some of the 28 ports in each CCU may be reserved to accommodate the dial-up lines. The number of ports required for back-up lines is variable, to be determined from the maximum number of RCU's on a single circuit, specified system availability requirements and leased line outage statistics.

10.2.2 MODEMS - The modems selected by the FAA for use at each installation will incorporate the features in paragraphs 10.2.2.1 and 10.2.2.2 into a single modem.

10.2.2.1 PRIMARY LINKS - Modems capable of handling full duplex, synchronous transmissions at 2400 bps shall be used to interface the leased lines with RCU's and CCU's. Thus there shall be one such modem at each RCU and one for each primary circuit (multipoint or point-to-point) at each CCU. Spare modems may be available in the event of modem failure. Coding and modulation requirements of Federal Standard 1005 shall be met.

10.2.2.2 BACK-UP LINKS - Modems capable of handling half-duplex, synchronous transmissions at 2400 bps shall be used for the back-up service. Thus there shall be one such modem at each RCU and one for each back-up port at each active CCU. Spare modems may be available in the event of modem failure. Dialing shall be accomplished using tone dialing (DTMF Standard) equipment employing an RS-366-A-79 or RS-232C interface.

As suggested earlier, the back-up system may be automatic or manual. If the fully automatic option is selected, automatic dial capability is require for the RCU back-up-line modems and automatic answer capability for the CCU back-up-line modems. Partially automated options are also feasible, involving either the automatic dial or the automatic answer capability, using tone dial signaling.

10.2.3 ELECTRICAL/MECHANICAL INTERFACE - The electrical/mechanical interface between the modems and the control units (RCU's and CCU's) shall be in accordance with EIA Standard RS-232C. The electrical/mechanical interface between the RCU's and its peripheral devices shall be RS-449 operating in the balanced mode or RS-232C.

10.3 SECTION 3, LINK CONTROL LEVEL

10.3.1 PROCEDURES - The link level protocol to be used between the RCU's and CCU shall be the bit-oriented ANSI X3.66, Advanced Data Communication Control Procedure (ADCCP). ADCCP provides for three classes of procedures. Only two of these shall be used for FDIO systems:

a. Unbalanced Normal (UN) - Such procedures involve one station designated as the primary station and any number of secondary stations. The primary controls the link through the transmission of commands. The secondaries transmit responses to commands. Both types of stations can transmit information (e.g., FDEP messages); however, secondary stations can do so only in response to a specific command (poll). This class of procedures shall be sued for FDIO multipoint links between RCU's and CCU and for the dial back-up links, with the CCU always designated as the primary station. Control function options 1 and 7 (as cited in section 10.3.8.2 of this document) shall be implemented.

b. Balanced Asynchronous (BA) - Under such procedures, each of the two stations on a point-to-point link is a combined (primary and secondary) station. As appropriate, either of the two stations can take on the primary role (send commands), causing the other to take on the secondary role (send responses). This class of procedures shall be used for the primary point-to-point links between RCU and CCU in each FDIO system. With a full duplex link, such as specified for primary FDIO circuits, no contention problems exist. Control function options 1, 2, 7, and 11 (as cited in section 10.3.8.2 of this document) shall be implemented.

The following subsections provide a general description of ADCCP focused on the two classes of procedures indicated above for FDIO application. Emphasis is placed on the procedure variations and options that must be implemented for FDIO. Greater detail can be found in the referenced ADCCP standards publication, ANSI X3.66-1979.

Because of the many similarities in the two classes of procedures, it will be convenient to use the terms primary and secondary, when applied to stations, to also include combined stations in the indicated roles. Thus "primary stations" should be understood to mean "primary stations under UN procedures and combined stations in the primary role under BA procedures."

10.3.2 FRAME STRUCTURE - The unit of transmission under ADCCP is the frame. A frame may, but need not, include a message block (information field); frames with no information field are used for link control only. Each frame transmitted from any type of station must contain the following, in the order indicated:

a. An opening flag sequence;

b. An address field;

c. A control field;

d. An information field (optional);

e. A frame check sequence; and

f. An ending flag sequence.

FLAG	ADDRESS FIELD	CONTROL FIELD	INFORMATION FIELD (OPTIONAL)	FCS	FLAG

10.3.3 FLAG SEQUENCE - The flag sequences serve to synchronize a frame. The flag sequence shall be the bit octet - 01111110. The sequence -- 011111101111110 — shall be recognized as two flag sequences. A single flag sequence can be used as the ending flag for one frame and the opening flag for the next frame.

Each receiving station shall constantly monitor the stream of bits received to identify the flag sequences. In order to avoid misinterpretation of other control data or information field contents as flag sequences, the transmitting station shall implement a "zero-bit insertion" process. This process requires that, prior to a transmission, a zero bit be inserted immediately following any sequence of five continguous one bits other than those in the flags. This includes all such sequences found in the string of bits constituting the address field, the control field, the information field (if present) and the frame check sequence.

In monitoring the input bit stream, the receiving station shall isolate all sequences of 5 one bits. When such a sequence is found, the next bit shall be checked. If that bit is a zero, 5 one bits shall be passed and the zero deleted. If the bit following the 5 one bits is another one bit, the receiving station shall check the next bit. If it is a zero, a flag is identified; otherwise an abort signal (7 to 14 contiguous one bits) is identified and the current frame is discarded.

10.3.4 ADDRESS FIELD - ADCCP requires that a unique address be associated with all secondary stations on a link (this includes all combined stations). Any transmission to or from a secondary station shall contain the address of that station in the address field. A transmission from a primary station to more than one secondary station on a multipoint line shall include a group or global address, which appropriate secondary stations shall be capable of recognizing.

ADCCP provides for a multi-octet address field. For FDIO applications, only a single octet shall be used. Nevertheless, in order to be consistent with the multi-octet option, the least significant bit of each address shall be 1. Address fields shall be transmitted with the least significant bit first, as indicated below:

b_1 b_2 b_3 b_4 b_5 b_6 b_7 b_8 MOST SIGNIFICANT BIT

ADDRESS OF SECONDARY

First bit transmitted
$b_1 = 1$

Since only the address of the secondary station is used, the address field indicates the respective roles of the combined stations under BA procedures. Thus if on a primary point-to-point link the CCU is assigned the address 0 and the RCU the address 1, the roles are identified as follows:

DIRECTION OF TRANSMISSION		ADDRESS FIELD 6 6 6 6 6 6 6 6	PRIMARY ROLE	SECONDARY ROLE	MEANING OF CONTROL SEQUENCE
CCU	RCU	1 1 0 0 0 0 0 0	CCU	RCU	Command
CCU	RCU	1 1 0 0 0 0 0 0	CCU	RCU	Response
CCU	RCU	1 0 0 0 0 0 0 0	RCU	CCU	Response
CCU	RCU	1 0 0 0 0 0 0 0	RCU	CCU	Command

The global address -- 11111111 -- Shall be used for transmissions being directed simultaneously to all RCU's on a multipoint line. For FDIO applications, group addresses (other than the global address) shall be used only to permit simultaneous transmission of messages to a tower and its associated radar approach control facility (e.g., TRACON), when they have distinct RCU's. It shall be a function of RCU firmware to determine to which specific printer at a site a message will be directed. The null address -- 00000000 -- shall be used in situations where it is desired to exercise a station's transmit abilities without requiring station action or reply.

10.3.5 CONTROL FIELD - The control field is used to indicate the nature of the transmission, to communicate commands and responses between primary and secondary stations and to acknowledge receipt of acceptable information frames. ADCCP permits use of a one- or two-octet control field. Only a single octet shall be used for FDIO applications. This limits the number of unacknowledged information frames, from one station to another, to seven.

In order to describe the structure of the control field, it is useful first to define a few related parameters and concepts.

10.3.5.1 CONTROL PARAMETERS AND CONCEPTS

a. Frame Sequence Number - Each station shall assign a sequence number to each information frame transmitted. A separate sequence of numbers shall be used for each station with which that station communicates. Such sequence numbers must fall in the range of 0 to 7 (000 to 111, in bit notation). Thus, after information frame 7 has been transmitted to a particular station, the next information frame transmitted to that station shall be assigned the sequence number 0 (i.e., the frame numbers are incremented by 1, modulo 8). A maximum of seven unacknowledged frames may exist between any two stations, in either direction.

b. Send Variable - Each station shall maintain a set of send variables, S(B). Each of these variables shall be initialized to 0 and then incremented by 1, modulo 8, whenever the transmission of an information frame to the particular station (B) is completed. (S(B) shall not be incremented when a frame is aborted.

c. Receive Variable - Each station shall similarly maintain a set of receive variables, R(A), which shall be initialized to 0. Each of these variables shall be incremenated by 1, modulo 8, whenever an information frame with sequence number equal to R(A) is received from the particular station (A). (Note that since al FDEP stations both send and receive messages, each shall maintain both send and receive variables.)

d. Poll/Final (P/F) Bit - One bit position within each control frame shall be used to transmit a poll or final (P/F) bit. The term poll bit is used in connection with transmissions from primary stations (i.e., commands). When the poll bit is transmitted (i.e., the P/F bit position in a primary station's transmission contains a 1) the secondary is "commanded" to respond. The term final bit is used in connection with transmissions from secondary stations (i.e., responses). When the final bit is transmitted, the secondary station is indicating that it has responded to a poll command. If the response is one or more information frames, the final bit shall be set only in the last frame transmitted in response to the poll.

10.3.5.2 CONTROL FIELD STRUCTURE - ADCCP groups the various types of frames into three categories - information (transfer), supervisory, and unnumbered. Each of these categories requires a distinct format for the control field. Information frames are the one generally used to transmit information (e.g., FDEP messages). The other frames may also contain information fields, but such information is generally for link control purposes. Information frames, on the other hand, can also be used to perform some link control functions. Supervisory and unnumbered frames are used to carry out link control functions.

The formats indicated below shall be used:

FRAME TYPE	FORMAT							
BIT POSITION:	1	2	3	4	5	6	7	8
INFORMATION	0		N(S)		P/F		N(R)	
SUPERVISORY	1	0	C	C	P/F		N(R)	
UNNUMBERED	1	1	M	M	P/F	M	M	M

NOTES:

a. The first or first and second bits indicate the format being used.

b. The fifth bit position shall always be used for the P/F bit.

c. N(S) shall be the value of the transmitting station's send variable, S(B), at the start of transmission.

d. N(R) shall be the value of the transmitting station's receive variable, R(B) at the start of transmission.

e. N(S) and N(R) shall be transmitted with the least significant bit first.

f. The third and fourth bits of the control field in supervisory frames (designated C) shall be used to identify the specific supervisory function. These are discussed latter.

g. Bit positions 3, 4, 6, 7, and 8 in unnumbered frames (designated M) shall be used to identify the specific unnumbered function. These also are defined later.

10.3.6 INFORMATION FIELD - When included, the information field is transparent to ADCCP, i.e., the link control procedures will accept almost all sequence of bits as an information field. There shall however, be a limit on the size of the field. For FDIO application, this limit shall be 2000 bits (or 250 8-bit characters), excluding the zero insertion bits discussed earlier. In order to transmit longer messages, the messages shall be broken into two or more blocks of 2000 (or fewer) bits and each block shall be transmitted in a separate frame.

Information frames will almost always include an information field. Supervisory frames shall never include an information field. Generally, unnumbered frames must not include such fields. There are two exceptions, however. An unnumbered frame for the function XID (exchange identification, discussed later) may optionally include an information field providing supervisory data. Similarly, if a non-reserved function (also discussed later) is used, an information field may be included in the frame.

10.3.7 FRAME CHECK SEQUENCE - The frame check sequence (FCS) shall be a 16-bit (2 octet) number generated at the transmitting station by applying a special algorithm to the string of bits that make up the address field, the control field and (if present) the information field, prior to zero insertion. The value of the FCS shall be determined and transmitted as part of each frame.

The receiving station, after removing the flag sequences and the inserted zeros, shall determine if the received FCS is consistent with the remainder of the transmission. Inconsistency implies an error in transmission and shall cause the transmission to be unacceptable.

APPENDIX D to ANSI X3.66-1979 defines the FCS in detail and suggests techniques for implementing this process.

10.3.8 CONTROL FUNCTIONS - As indicated earlier, ADCCP provides for a variety of control functions. These are defined as a series of basic commands and responses together with a series of optional commands and responses. The referenced ANSI standard for ADCCP describes all of these functions in detail. The following outlines those that shall be implemented for FDIO applications.

10.3.8.1 BASIC FUNCTIONS - The basic control functions include both commands (i.e., from primary stations) and response (i.e., from secondary stations). There is a slight difference depending on the class of procedures (UN or BA) used. The following identifies these functions as they apply to FDIO:

FUNCTION	COMMAND/RESPONSE	MEANING
I	C&R	Information being transferred
RR	C&R	Receive Ready

FUNCTION	COMMAND/RESPONSE	MEANING
RNR	C&R	Receive Not Ready
FRMR	R	Frame Reject
SNRM	C	Set Normal Response Mode (UN procedures only).
SABM	C	Set Asynchronous Balanced Mode (BA procedures only).
DISC	C	Disconnect
UA	R	Unnumbered Acknowledgement
DM	R	Disconnected Mode

In addition there is a basic command RSET (Reset) for BA procedures which will not be used for FDIO.

10.3.8.2 OPTIONAL FUNCTIONS - ADCCP provides eleven options for adding or deleting control functions or modifying basic formats. The ones that shall be implemented for FDIO are:

OPTION#	ADD/ DELETE	COMMAND/ RESPONSE	FUNCTION	MEANING
1 (a)	A	C&R	XID	Exchange Identification
(b)	A	R	RD	Request Disconnect
2	A	C&R	REJ	Reject
7	A	C&R	See Para 4.3 in ANSI X3.66	Extended Address Format
11	D	C	RSET	(Delete the Basic Reset Command)

In addition ADCCP provides up to four non-reserved functions that can be defined and implemented by the system designer. No such functions are envisioned as being needed for FDIO.

10.3.8.3 FUNCTION CODES - The various functions indicated above shall be designated through codes in the control field of a frame. The information transfer function, I, shall be designated directly by the use of an information transfer format (0 in bit position 1, see section 10.3.5.2). The remaining functions shall be designated as follows:

a. SUPERVISORY FRAMES

FUNCTION	CONTROL FIELD BIT POSITIONS	
	3	4
RR	0	0
RNR	1	0
REJ	0	1

b. UNNUMBERED FRAMES

FUNCTION	CONTROL FIELD BIT POSITIONS					
	3	4	5	6	7	8
SNRM	0	0	P	0	0	1
SABM	1	1	P	1	0	0
DISC	0	0	P	0	1	0
XID	1	1	P/F	1	0	1
UA	0	0	F	1	1	0
DM	1	1	F	0	0	0
FRMR	1	0	F	0	0	1
RD	0	0	F	0	1	0

10.3.9 EXCEPTION CONDITIONS - Six exception conditions can be anticipated in the FIDO applications of ADCCP. These are described briefly below. The referenced ANSI standard for ADCCP should be used for greater detail.

10.3.9.1 BUSY CONDITION - A station is considered "busy" when, due to internal constraints (e.g., buffer limitations), it temporarily cannot accept additional information frames. Such a condition shall be reported at the first opportunity to all other appropriate stations using an RNF frame.

Upon receipt of an RNR frame, a station shall cease transmitting information frames to the busy station. An information frame in the process of being transmitted can be aborted or completed. Transmission of other types of frames to or from the busy station can continue during the busy condition. A busy condition shall be reported to the system supervision position.

The clearance of a busy condition shall be reported by:

a. Transmission of an RR, REJ, SNRM, SABM or UA frame, with or without the P/F bit set to 1, or

b. Transmission of an information frame with the P/F bit set to 1.

10.3.9.2 FCS ERROR - Errors introduced during the transmission of a frame will almost always cause an FCS error, i.e., cause the received value of the FCS to differ from the expected value. Frames received with such an error shall be discarded. No other specific action shall be taken when such an error is detected.

10.3.9.3 FRAME REJECT CONDITION - When a frame is received with no FCS error, but contains (1) an invalid control field, (2) an invalid N(R) or (3) an information field with more than 2000 bits, a frame reject condition exists. A secondary station, upon detecting such a condition, shall notify the primary station with an FRMR response. A primary station upon detecting such an error or upon receiving an FRMR response shall transmit a mode setting command (SNRM, SABM, or DISC).

10.3.9.4 FRAME SEQUENCE ERROR - Whenever a station receives an otherwise error-free information frame, it shall check to insure that the value of N(S) corresponds to the receive variable R(A). If the two are not identical, a frame sequence error has occurred. At the earliest opportunity the receiving station shall transmit an REJ frame to the original transmitting station, with N(R) set to R(A). The information field(s) from the eroneous frame and any subsequent information frames from that transmitting station shall be discarded, until one with N(S) equal to R(A) is received. Other control information (e.g., the P/F bit and N(R)) from those frames will be used. However, the original transmitting station, upon receiving the REJ frame shall retransmit the erroneous frame and any subsequent information frames (in order) at the earliest opportunity.

10.3.9.5 UNACKNOWLEDGED FRAMES - Each time a station receives an information or supervisory frame, it expects acknowledgement (through the N(R) parameter) of information frames it transmitted. To facilitate retransmission of unacknowledged information frames, each station shall implement checkpoint recovery, as follows:

a. A checkpoint cycle is defined (1) for a primary station, as the period between the transmission of a P bit and the next receipt of an F bit from the secondary to which the P bit was directed, and (2) for a secondary station as the period between the transmission of an F bit and the next receipt of a P bit from the primary. (A cycle does not end with an unnumbered frame, however.)

b. When a primary/combined station receives a frame with the F bit set to "1" or when a secondary station receives a frame with the P bit set to "1," the station will initiate retransmission of all unacknowledged I frames with sequence numbers less than the send variable (S) at the time the last frame with the P bit set to "1" (primary/combined) or frame with the F bit set to "1" (secondary) was transmitted. Retransmission starts with the lowest numbered unacknowledged I frame. I frames are retransmitted sequentially. New frames may be transmitted if they become available. Such retransmission of I frames is known as checkpoint retransmission.

c. If an REJ frame with the P/F bit set to 0 is received during such a cycle, actions pertinent to the REJ condition, rather than checkpoint retransmission, will be implemented.

d. See ADCCP, ANSI X3.66-1979 for further details and exceptions.

10.3.9.6 TIME-OUT - Often an expected acknowledgement or response is not received due to transmission losses or FCS errors (for message in either direction). To help detect such conditions efficiently, time-out functions shall be implemented. Time-out functions shall (1) initialize a timer when a transmission requiring an acknowledgement or response is sent, (2) stop the timer when the acknowledgement or response is received, and (3) note a time-out condition when a prespecified time has elapsed without the expected acknowledgement or response having been received. If the time-out condition occurs, recovery actions shall be taken, involving retransmission of the frame that started the process.

For FDIO applications, at least two time-out functions shall be included. One for polls from primary stations and one for REJ frames (with the P/F bit set to 1) from either primary or secondary stations. These functions shall recognize a time out condition after 8 seconds have elapsed.

10.4 SECTION 4, MESSAGE LEVEL

10.4.1 CODE SET - The information fields of FDIO transmissions between RCU's and CCU's shall be constructed using the IA-5 seven level ASCII code (referenced FAA Order 1830.2). This code has also been specified as the one to be generated and accepted by remote FIDO replacement equipment. This code, however, is not used by the NAS 9020 computer; hence the CCU shall perform the necessary code conversion.

10.4.2 MESSAGE FORMAT - The message format shall be consistent with that specified for NADIN. NADIN message format requirements are defined in APPENDIX A, BB, FF of the NADIN specification FAA-E-2661a for the ANSI X3.66 interface. The requirements presented here include, therefore, only the details currently available. Items designated "to be specified by NADIN" shall be handled as follows:

a. At the time these elements are to be implemented for FDIO, it shall be determined if they have been specified for NADIN.

b. If so, the NADIN requirements shall be implemented. If not, the FDIO contractor can handle these elements in an established manner, but with the understanding that modifications might be required at a later time (i.e., in a way that shall facilitate such subsequent modifications).

c. If the latter approach is used appropriate modifications shall be made at such time that FDIO may be integrated into NADIN.

10.4.2.1 MESSAGE SIZE AND COMPONENTS - The length of the information field shall not exceed 250 characters (2000 bits). This includes the three required components of the field:

a. A heading, containing supervisory and communications information;

b. The text, i.e., the message being transferred, and

c. An ending, i.e., a character denoting the end of the message.

Should the message be so long as to cause the combined length of the three components to exceed 250 characters, the message shall be broken down into two or more sections. Each message block shall be imbedded in a separate transmission frame, with its own heading and ending.

10.4.2.2 MESSAGE HEADING - The message heading shall consist of the following elements. The elements shall be organized in lines as indicated and no line shall exceed 69 characters in length.

10.4.2.2.1 START OF HEADING - The start of heading indicator shall consist of SOH (ASCIi character 0/1) followed by GS (ASCII character 1/13).

10.4.2.2.2 SUPERVISORY INFORMATION - Supervisory information shall consist of a transmission identification to be specified by NADIN. The number of characters involved shall not exceed the remainder of the line. The line shall end with CR LR (ASCII characters 0/13 and 0/10).

10.4.2.2.3 PRIORITY INDICATOR - The priority shall be indicated with two alphabetic characters. ATC data shall use FF; weather and general messages shall use GG.

10.4.2.2.4 ADDRESSES - Each address shall consist of a space and six, or eight characters to identify each destination for the message. The end of each line of addresses shall be completed with CR LF. The last address (three lines maximum) shall be followed by CR LF File Separator (FS). Address designators will be assigned by NADIN. Even without NADIN, such address shall be included in order that the CCU can direct messages to the appropriate port and the appropriate RCU. The address for St. Louis ATCT would be KSTLZT__, where the last two characters identify the device address at St. Louis.

10.4.2.2.5 DATE TIME GROUP - The date time group shall consist of six numerics indicating the day, hour, and minute the message was prepared on a radio day basis.

10.4.2.2.6 MESSAGE ORIGINATOR - The originator of the message shall be identified with the ICAO address (six or eight characters) of the terminal location entering the message, followed by the optional data field and CR LF STX. NADIN will assign the address codes required.

10.4.2.2.7 ADDITIONAL DATA FIELD - The additional data field shall be used to convey additional data of use to the users of the network and shall consist of one to three sub-fields of variable length. The field is delimited by space and CR LF STX and shall contain a maximum of 32 characters. Sub-fields may be used in any combination and shall be delimited as shown in Figure 1. Sub-field A is for data of interest to the network and users, Sub-field B is of interest to the users, and Sub-field C is of interest to the network. Elements in any sub-field shall be optional and preceded by the element number and a period. Each element shall be terminated with a hyphen (ASCII character 2/13). Specific character assignments for these elements will be made by NADIN.

10.4.2.2.7.1 SUB-FIELD A - Elements in this sub-field shall have the following meanings.

10.4.2.2.7.1.1 ELEMENT 1, MESSAGE TYPE - Three to eight characters for message type as the first field in the message text, for text using a character or bit structure other than ASCII, or for duplicate messages. NADIN may insert a fixed message type based on message originator.

10.4.2.2.7.1.2 ELEMENT 2, PRIVACY - Not required for FDIO.

10.4.2.2.7.1.3 ELEMENT 3, ACKNOWLEDGEMENT - One character to indicate the type of system acknowledgement required for the message. This shall include generation of the necessary messages between NADIN and the message originator.

10.4.2.2.7.1.4 ELEMENT 4, BILLING - Not required for FDIO.

10.4.2.2.7.1.5 ELEMENT 5, TEXT CODE AND FORMAT - Two characters are required to indicate the code and format of the text.

10.4.2.2.7.1.6 ELEMENT 6, TEXT LENGTH - Not required for FDIO.

10.4.2.2.7.2 SUB-FIELD B - Elements in this sub-field shall have the following meanings.

10.4.2.2.7.2.1 ELEMENT 1, AUTHENTICATION KEY - Not required for FDIO.

10.4.2.2.7.2.2 ELEMENT 2, POSSIBLE DUPLICATE MESSAGE - Three characters (PDM) shall be used to indicate a possible duplicate when NADIN cannot logically determine absolute message accountability during recovery.

10.4.2.2.7.2.3 ELEMENT 3, FILE NUMBER - ADP file number, as agreed by users.

10.4.2.2.7.2.4 ELEMENT 4, DATA SEQUENCE NUMBER - Two characters shall be used to indicate messages submitted to NADIN which must be reassembled by the destination user to form a complete message. This number will be assigned by the originator, and NADIN will not be sensitive to it. The final number shall be followed immediately by the ASCII character F. This is only required for messages which are broken into blocks to meet the size limitation.

10.4.2.2.7.3 SUB-FIELD C - Sub-field C may be used later for additional information which at the present must remain undefined.

10.4.2.3 MESSAGE TEXT - The message text shall consist of the information to be transferred (e.g., an FDIO Remote Group message). The message text in any one message shall be limited by the originator such that the total message length (including heading and ending but excluding any insertions made by the channel control procedures) shall not exceed 250 characters. In those cases where the information to be transferred exceeds the allowable limit, the originator shall divide this information and form a sequence of messages, each with its own heading and ending and each within the allowable size limit. The data Sequence Number (Optional Data Field, Sub-Field B, Element 4 of the heading) shall be used to identify the relative position of each message in the sequence for convenience in reassembling them at the destination. Example: /4.02 as the second page of text.

10.4.2.4 MESSAGE ENDING - The message ending shall consist of CR LF VT followed by the end-of-text character, ETX (ASCII 0/3).

SPACE Sub-field A / Sub-field B / Sub-field C CR LF STX

17 69

(a) Optional Data Field

SPACE CR LF STX

17 69

(b) Sub-field A Only

SPACE / CR LF STX

17 69

(c) Sub-field B Only

SPACE // CR LF STX

17 69

(d) Sub-field C Only

SPACE A / B CR LF STX

17 69

(e) Sub-field A and B

SPACE A // C CR LF STX

17 69

(f) Sub-field A and C

SPACE / B / C CR LF STX

17 69

(g) Sub-field B and C

Figure 1, APPENDIX 1, Optional Data Field -- Sub-Field Delimiters

APPENDIX II

20. - 9020 CCC - FDIO CONTROL UNIT

INTERFACE CONTROL DOCUMENT

20.1.1 SECTION 1. - INTRODUCTION

20.1.1. PURPOSE - The information contained herein describes the interface control requirements for communications links between the NAS 9020 computer at each Air Route Traffic Control Center and the colocated FDIO control units. Both the Central Control Units (CCUs) and the Printer Control Units (PCUs) are considered.

To the degree pertinent, the procedures have been developed so as to be identical for both CCUs and PCUs. Further, they have been designed to be compatible with procedures specified for the interface between the NAS 9020 and the NADIN concentrator (which may functionally replace the CCU). See NAS-MD-750 or FAA-E-2661a, APPENDIX F for the NADIN/NAS 9020 Interface procedures and see the Processor input/output channel (PIOC) to NADIN input and output interface Specification for hardware interface connection details.

Should the NADIN concentrator be used in place of the CCU, only those requirements presented below that are applicable to the NAS 9020/PCU interface shall apply.

20.1.2. SCOPE - This paper addresses interface control requirements at three levels:

a. Physical, i.e., the communications lines;

b. Link, i.e., the control of transmissions; and

c. Message, i.e., the actual data transmitted.

20.1.3. SYSTEM OVERVIEW - The FDIO communications considered here are of three basic types: (1) output messages, i.e., transmissions from the NAS 9020 to terminals (printers) located either at remote FDEP sites or at the Center, (2) input messages, i.e., transmissions from terminals (keyboards) at remote FDEP sites to the NAS 9020, and (3) supervisory messages. Under the FDIO replacement program all such communications shall be routed through control units (concentrators) colocated with the NAS 9020 at the Center.

The control units fuctions involve both transmissions to and from the NAS 9020 and to and from the terminals. This paper is concerned only with the former pertinent functions related to output messages from the NAS 9020 to CCUs and PCUs include:

a. Determination of output message acceptability and the initiation of recovery procedures when an unacceptable message is received;

b. Buffering of acceptable output messages for subsequent transmission to terminals; and

c. Conversion of output message text from EBCDIC to ASCII code.

Pertinent functions related to input messages (from the FDIO Control Units to the NAS 9020) include:

d. Conversion of input message text from ASCII to EBCDIC code;

e. Implementation of link control procedures for input messages;

f. Transmission of input messages to the NAS 9020; and

g. Implementation of recovery procedures when the NAS 9020 is down or otherwise not accepting input.

The functions of the NAS 9020 computer relative to such transmissions include:

h. Implementation of link control procedures for output messages;

i. Transmission of out messages;

j. Determination of input message acceptability and the initiation of recovery procedures when an unacceptable message is received; and

k. Implementation of recovery procedures when a control unit goes down.

Under the FDIO replacement program, the typical Center will contain two CCUs and four PCUs. One CCU and two PCUs are generally required for standard operations; the other units are included as one-on-one back-ups in case of equipment failure.

20.1.4. REFERENCES

(a) FAA Order 1830.2, February 7, 1978, "Policy for Use of Tele-communications Data Transfer Standards".

(b) ANSI X.3.4-1968, "The American National Standard Code for Information Interchange.

(c) FAA Specification FAA-E-2661a, November 5, 1982 "National Airspace Data Interchange Network (NADIN)."

(d) IBM form A27-2709-1, "IBM 9020 System Input/Output Operations Reference for IBM 7289-02 Peripheral Adaptor Module (PAM)".

(e) IBM 9020 - Design Data.

(f) NAS-MD 314, "Local Outputs".

(g) NAS-MD 315, "Remote Outputs".

(h) NAS-MD 311, "Message Entry and Checking".

(i) NAS-MD 750, "NADIN/NAS 9020 Interface" or "FAA-E-2661a APPENDIX F".

(j) PIOC to Nadin Input and Output Interface Specification.

20.2. SECTION 2, PHYSICAL CONTROL LEVEL - The physical connection between each control unit and the NAS 9020 computer shall be via cable through General Purpose Output (GPO) and General Purpose Input (GPI) ports in the Peripheral Adapter Module (PAM) of the computer. Each cable shall provide line for bit-parallel, byte-serial transmission of EBCDIC code (8 data bits plus parity bit) and additional device control lines. FIGURES 1 and 2 identify the lines for the input and output links, respectively. Additional details on this interface are provided by the referenced IBM Form A27-2709-1. FIGURE 3 shows the connection of all active and redundant control units at an ARTCC with both primary and secondary designated PAMS.

DATA LINES (9)	SIGNAL INITIATED BY
PARITY BIT	CCU/PCU
BIT POSITION 0	CCU/PCU
BIT POSITION 1	CCU/PCU
BIT POSITION 2	CCU/PCU
BIT POSITION 3	CCU/PCU
BIT POSITION 4	CCU/PCU
BIT POSITION 5	CCU/PCU
BIT POSITION 6	CCU/PCU
BIT POSITION 7	CCU/PCU

CONTROL LINES (6)	SIGNAL INITIATED BY
I/O REQUEST	CCU/PCU
ADAPTER RESPONSE	PAM
DEVICE CONTROL LINE 1 (DC1)	PAM
DC3	PAM
DC4	PAM
END OF MESSAGE (EOM)	CCU/PCU

FIGURE 1, APPENDIX II, CONTROL UNIT/GPI PHYSICAL INTERFACE

DATA LINES (9)	SIGNAL INITIATED BY
PARITY BIT	PAM
BIT POSITION 0	PAM
BIT POSITION 1	PAM
BIT POSITION 2	PAM
BIT POSITION 3	PAM
BIT POSITION 4	PAM
BIT POSITION 5	PAM
BIT POSITION 6	PAM
BIT POSITION 7	PAM

CONTROL LINES (9)	SIGNAL INITIATED BY
I/O REQUEST	CCU/PCU
ADAPTER RESPONSE	PAM
DEVICE INOPERATIVE	CCU/PCU
DEVICE STATUS LINE 3 (DS3)	CCU/PCU
DS5	CCU/PCU
DS6	CCU/PCU
DS7	CCU/PCU
ADAPTER SELECTED	PAM
END OF MESSAGE (EOM)	PAM

FIGURE 2, APPENDIX II, CONTROL UNIT/GPO PHYSICAL INTERFACE

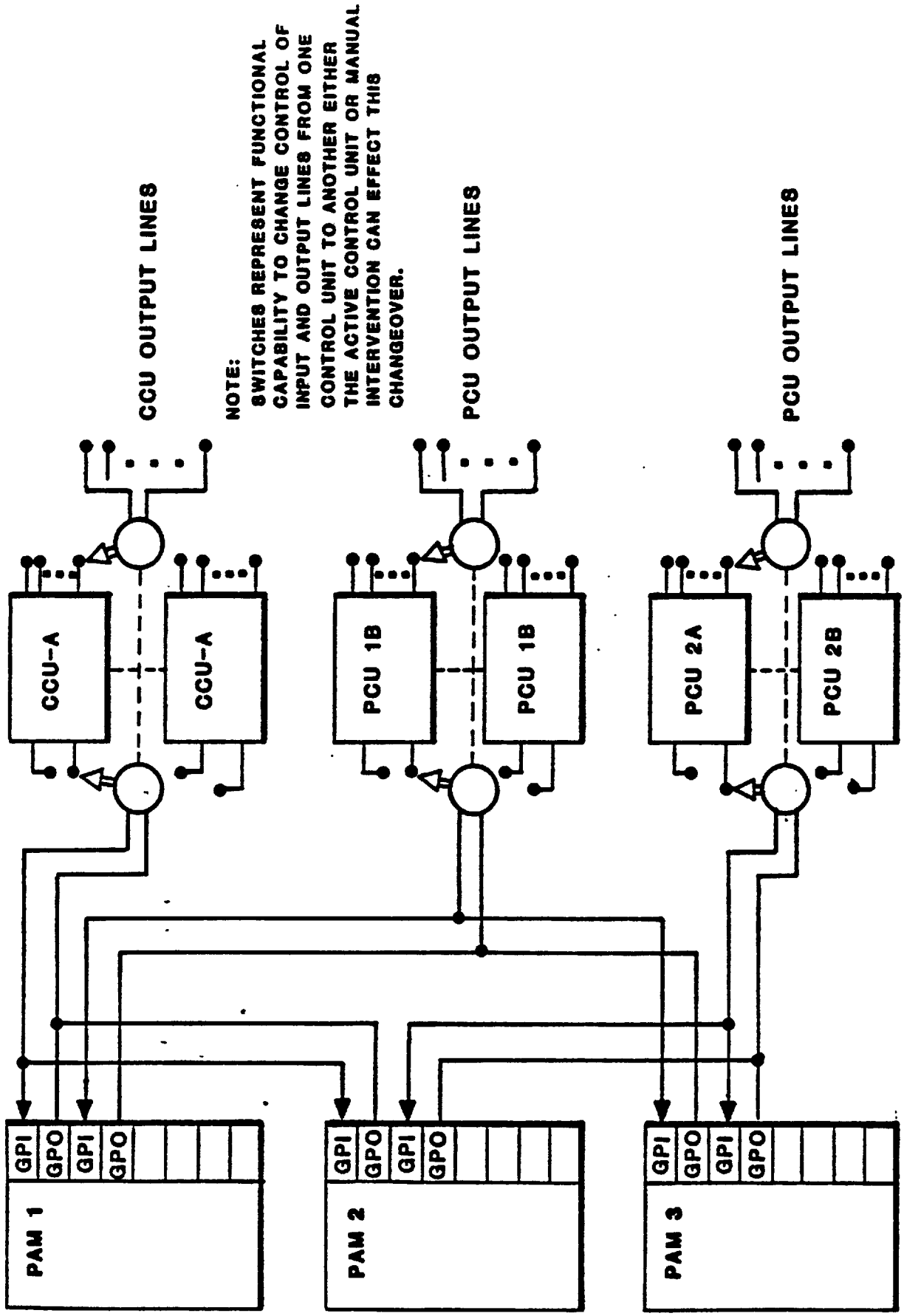

Figure 3. Appendix II, Control Unit – PAM Interface (Typical)

20.3. SECTION 3, LINK CONTROL LEVEL - Link control shall be implemented by use of the control lines identified in FIGURES 1 and 2. These procedures are discussed below.

20.3.1. INPUT TRANSMISSIONS (GPI/CCU AND GPI/PCU INTERFACES - Whenever the NAS 9020 is able to receive transmission from a CCU or a CCU or PCU, control line DC1 shall be raised by the PAM. DC1 shall not be dropped until such time as the computer cannot or will not accept transmissions from the CCU or PCU. When the CCU or PCU has a message to transmit to the NAS 9020, it shall first determine if DC1 is up. If so, the CCU or PCU shall raise the I/O Request line and transmit one byte at a time in accordance with the procedures specified in IBM 9020 design data. The end of message shall be signaled by raising the EOM control line. Successive I/O request activations shall be separated in time by an interval greater than 25 microseconds.

20.3.2. OUTPUT TRANSMISSIONS (GPO/CCU and GPO/PCU INTERFACES) - The control units, by use of the Device Inoperative control line, shall inform the NAS 9020 of their status. If the control unit is available, the computer shall output pertinent messages as they are generated. The end of each message shall be signaled by raising the EOM control line.

20.3.3. PRINT CONFIRMATION TRANSMISSIONS (GPI/CCU AND GPI/PCU INTERFACES) When the NAS 9020 transmits FDIO messages to either a CCU or a PCU, the control unit shall buffer these messages until they can be processed and ultimately printed. Each time a message is successfully printed, the CCU or PCU shall transmit a confirmation to the 9020 using the link control described under Input Transmissions, paragraph 10.3.1., above. The sequence used to identify individual messages shall be limited to the first eight characters of the text.

20.3.4. EXCEPTION RECOVERY - Two types of situations may occur on these interfaces which disrupt standard operations - transmission errors and system failures. The system shall respond as follows to those conditions.

20.3.4.1. TRANSMISSION ERRORS - Transmission errors are detected as parity errors. If a control unit detects such an error in a byte of an output message, it shall raise the DS3 control line. The NAS 9020, upon sensing this, shall retransmit the byte. If the NAS 9020 detects a parity error in an input byte, it shall raise the DC3 control line. The CCU or PCU, upon sensing this, shall retransmit the byte.

20.3.4.2. SYSTEM FAILURE - Generally, system failures will be detected through the control lines. Thus the loss of DC1 will indicate a computer failure and the activation of the Device Inoperative line will indicate a control unit failure. In addition, the computer and control units will maintain time-out functions. Detection of an intercharacter delay in excess of six milliseconds in received messages shall be interpreted as a failure in the transmitting device.

When an active CCU (PCU) has determined through self-diagnosis that a internal malfunction has occured or is imminent, it shall automatically cause a switchover to the redundant CCU (PCU). Whenever a new CCU (PCU) gains control, it shall transmit a supervisory message to the NAS 9020 (via the GPI interface) indicating the change. The 9020 shall then output this alert on an appropriate output device for the attention of the Systems Engineer.

If an active CCU (PCU) malfunctions in a way which is undetected internally, but which results in either activation of the Device Inoperative line or aberrant behavior discernible by the 9020, then the 9020 shall transmit a supervisory message to the CCU (PCU) (via the GPO interface) ordering it to cause a switchover to the redundant CCU (PCU). If proper operation cannot be reestablished by this action the 9020 shall attempt to communiate with the active CCU (PCU) using the secondary GPI/GPO addresses. The 9020 shall then generate an alert on an appropriate output device which summarizes these events and the results. If necessary, a switchover from the active (but presumably malfuentioning) CCU (PCU) to its backup shall be performed manually.

When the CCU detects failure of the NAS 9020, it shall continue to accept input messages up to the capacity of the buffer. The CCU will then notify the remote units that it cannot accept input (Receive Not Ready) until the NAS 9020 is again accepting input and the buffer load is reduced.

20.4. SECTION 4, MESSAGE LEVEL

20.4.1. CODE SET - All transmissions to and from the NAS 9020 computer shall use the EBCDIC code. It shall be the function of the CCU and PCUs to provide conversion to and from the IA-5(ASCII) code used by all FDIO terminal equipment. Only those EBCDIC characters that can be converted to ASCII shall be used. TABLE 1 identifies this set and indicates the appropriate conversions.

20.4.2. MESSAGE FORMAT - The basic FDIO messages shall be embedded in a six-field message block. The field contents are indicated below:

FIELD	1	2	3	4	5	6
9020 Output Messages	Priority	Space	Address	CR/LR	STX	Text
(mod 4) 9020 Input Messages	~~Date-Time Group~~	Space	Originator Address	CR/LR	STX	Text

20.4.2.1. FIELD 1. - The first field shall be used to indicate message priority for output messages and the date-time group for input messages. Priority shall be designated by a two-character code as follows:

(a) GG, for lower priority messages, such as weather and general information.

(b) FF, for other FDIO messages.

(mod 4) ~~The date-time group shal be six numeries indicating the day, hour, and minute (DDHHMM).~~

20.4.2.2. FIELD 2. - The second field shall always be a single space character used as a delineator.

20.4.2.3. FIELD 3. - The third field shall contain the address of the station originating a 9020 input message or the address(~~es~~) of the station(~~s~~) designated to receive a 9020 output message. Individual addresses shall ~~consist of 6 or 8 characters, depending upon the address assignment for the particular location. Multiple addresses shall be used only for output messages and shall be separated by single space characters. The total field shall not exceed 67 characters including the spaces.~~ INCLUDE UP TO Eight CHARACTERS AND will SPECIFY THE STATUS AS WELL AS ITS RCH (IF APPLICABLE)

20.4.2.4. FIELD 4. - The fourth field shall contain two characters-carriage return (CR) and line feed (LF)-used as a delimiter.

20.4.2.5. FIELD 5. - The fifth field shall contain the start of text character, STX (GEX 02), indicating that the text follows.

20.4.2.6.	*	xvii.	20.4.2.6.	Delete the first paragraph substitute the following in lieu thereof:

Mod 4

A - TYPE	B - TEXT

However, several functions presently performed in the 9020 shall be deleted. Specifically, existing requirements for EBCDIC - PT&T code conversion, addressing, polling and the insertion of idle characters (to compensate for carriage motion delays) are all removed. Instead, the supervisory information required in preparing or interpreting FDIO messages shall be combined with the text in producing multified message blocks as defined in paragraph 20.4.2., Message Format.

The text for 9020 input message shall have length limitations as in the existing system, described in NAS-MD 311. The contents shall be as entered at the terminal (RCU) or preplanned supervisory commands or responses converted to EBCDIC.

*	xviii		Add the following new paragraphs:
		20.4.2.6.1.	Subfield A - This field is two characters long and identifies the specific type of NAS-FDIO message. Different messages (i.e., Fight Strip Diagnostic, Error status, etc.) will have different type fields.
*	xix	20.4.6.2	Rename paragraphs 2 and 3 to "20.4.2.6.2. subfield B - However. . ."
*	xx		Delete all references to Federal Standard 1031.

Mod 4

*ASTERICK DENOTES VARIANCE WAIVER DEVIATION GRANTED BY THE GOVERNMENT.
**PERMANENT CHANGE TO SPECIFICATION FAA 2711A DATED SEPTEMBER 26, 1983.

TABLE 1

EBCDIC/ASCII CONVERSION

SYMBOLIC NAME	HEX REPRESENTATION EBCDIC	ASCII	MEANING
NUL	00	00	NUL/IDLE
SOH	01	01	START OF HEADING
STX	02	02	START OF TEXT
ETX	03	03	END OF TEXT
EOT	37	04	END OF TRANSMISSION
ENQ	2D	05	ENQUIRY
ACK	2E	06	ACKNOWLEDGE
BEL	2F	07	AUDIBLE OR ATTENTION SIGNAL
BS	16	08	BACKSPACE
HT	05	09	HORIZONTAL TABULATION
LF	25	0A	LINE FEED
VT	0B	0B	VERTICAL TABULATION
FF	0C	0C	FORM FEED
CR	0D	0D	CARRIAGE RETURN
SO	0E	0E	SHIFT OUT
SI	0F	0F	SHIFT IN
DLE	10	10	DATA LINK ESCAPE
DC1	11	11	DEVICE CONTROL 1
DC2	12	12	DEVICE CONTROL 2
DC3	13	13	DEVICE CONTROL 3
DC4	3C	3C	DEVICE CONTROL 4
NAK	3D	15	NEGATIVE ACKNOWLEDGE

SYMBOLIC NAME	HEX REPRESENTATION EBCDIC	ASCII	MEANING
SYN	32	16	SYNCHRONOUS IDLE
ETB	26	17	END OF TRANSMISSION BLOCK
CAN	18	18	CANCEL
EM	19	19	END OF MEDIUM
SUB	3F	1A	SUBSTITUTE
ESC	27	1B	ESCAPE
FS	1C	1C	FILE SEPARATOR
GS	1D	1D	GROUP SEPARATOR
RS	1E	1E	RECORD SEPARATOR
US	1F	1F	UNIT SEPARATOR
SP	40	20	SPACE
!	4F	21	EXCLAMATION MARK
"	7F	22	QUOTATION MARK
#	7B	23	NUMBER
$	5B	24	DOLLAR
%	6C	25	PERCENT
&	50	26	AMPERSAND
'	7D	27	APOSTROPHE
(	4D	28	OPEN PARENTHESES
)	5D	29	CLOSE PARENTHESES
*	5C	2B	ASTERISK
+	4E	2B	PLUS
,	6B	2C	COMMAN
-	60	2D	HYPHEN

SYMBOLIC NAME	HEX REPRESENTATION EBCDIC	ASCII	MEANING
.	4B	2E	PERIOD
/	61	2F	SLANT
0	F0	30	ZERO
1	F1	31	ONE
2	F2	32	TWO
3	F3	33	THREE
4	F4	34	FOUR
5	F5	35	FIVE
6	F6	36	SIX
7	F7	37	SEVEN
8	F8	38	EIGHT
9	F9	39	NINE
:	7A	3A	COLON
;	5E	3B	SEMICOLON
	4C	3C	LESS THAN
=	7E	3D	EQUAL
	6E	3E	GREATER THAN
?	6F	3F	QUESTION MARK
@	7C	40	AT
A	C1	41	UPPER CASE ALPHABETICS
B	C2	42	
C	C3	43	
D	C4	44	

SYMBOLIC NAME	HEX REPRESENTATION EBCDIC	ASCII	MEANING
E	C5	45	
F	C6	46	
G	C7	47	
H	C8	48	
I	C9	49	
J	D1	4A	
K	D2	4B	
L	D3	4C	
M	D4	4D	
N	D5	4E	
O	D6	4F	
P	D7	50	
Q	D8	51	
R	D9	52	
S	E2	53	
T	E3	54	
U	E4	55	
V	E5	56	
W	E6	57	
X	E7	58	
Y	E8	59	
Z	E9	5A	
	4A	5B	OPEN BRACKET

SYMBOLIC NAME	HEX REPRESENTATION EBCDIC	ASCII	MEANING
	E0	5C	REVERSE SLANT
	5A	5D	CLOSED BRACKET
	5F	5E	CIRCUMFLEX
_	6D	5F	UNDERLINE
	79	60	GRAVE ACCENT
a	81	61	LOWER-CASE ALPHABETICS
b	82	62	
c	83	63	
d	84	64	
e	85	65	
f	86	66	
g	87	67	
h	88	68	
i	89	69	
j	91	6A	
k	92	6B	
l	93	6C	
m	94	6D	
n	95	6E	
o	96	6F	
p	97	70	
q	98	71	
r	99	72	
s	A2	73	

SYMBOLIC NAME	HEX REPRESENTATION EBCDIC	ASCII	MEANING
t	A3	74	
u	A4	75	
v	A5	76	
w	A6	77	
x	A7	78	
y	A8	79	
z	A9	7A	
	60	7B	SOUTH (DOWN) ARROW (OPEN BRACE)
	6A	7C	VERTICLE LINE
(CLOSE BRACE)	D0	7D	NORTH (UP) ARROW
	A1	7E	OVERLINE
DEL	07	7F	DELETE

BIT POSITIONS	
0 1 2 3 4 5 6 7	EBCDIC
7 6 5 4 3 2 1	ASCII

APPENDIX III

DATA ITEM DESCRIPTION	2 IDENTIFICATION NO(S)	
	AGENCY	NUMBER
1 TITLE "AS BUILT" CONFIGURATION DATA LIST	Navy-SE	UDI-E-20409B

3 DESCRIPTION/PURPOSE

This item of data also known as a "Configuration Log Book", "Configuration Sheet" or "Hardware Configuration List (HCL)" is a certified list of all specifications/drawings used to fabricate each delivered unit. It is a means of providing configuration accounting required by the configuration management plan.

4 APPROVAL DATE: 20 DEC 1976

5 OFFICE OF PRIMARY RESPONSIBILITY: SEA-06G4

6 DDC REQUIRED

7 APPLICATION/INTERRELATIONSHIP

8 APPROVAL LIMITATION

9 REFERENCES (Mandatory or Guidance)

10 PREPARATION INSTRUCTIONS

10.1 The "AS BUILT" Configuration Data List shall be in the contractor's format and include but not necessarily be limited to the following:

a. System/Equipment MARK and MOD or AN number and nomenclature.
b. Item serial number or lot number.
c. Item specification and/or drawing number and revision letter.
d. Technical Data Baseline.
e. Approved changes (Class I and II), deviations and waivers to the Technical Data Baseline.
f. Lower indentured components and/or assemblies serial numbers.
g. Date of shipment from factory (year, month) and destination
h. Test Data as prescribed by the government.
i. Certified statement that the above information describes the serialized/lot identified item delivered.

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U.S. GOVERNMENT PRINTING OFFICE 1971—716-377/1000 2 1 D-6617

APPENDIX IV

ATTACHMENT 2 ; NAS DOCUMENTATION STANDARDS
——— DEC-10 SYSTEM STANDARDS———

1.0 STANDARDS. The standards prescribed herein have been devised to minimize the manual input effort required by NAS Documentation Services and to be compatible with planned system enhancements,e.g., optical character readers. Where these standards conflict with existing standards, the existing standards shall prevail if required. However, originators should realize that any deviations from the standards specified herein will require longer processing times.

2.0 INPUT HARD COPY TEXT STANDARDS.

a. Sequence of Parts. The following standard sequence of parts of a typical NAS document shall be used where applicable:

(1) Notice Page (designating complete revision or change page package). Not required for new document.

(2) Cover.

(3) Change History. Not required for new document.

(4) Preface.

(5) Table of Contents (to 3-digit secondary sidehead level).

(6) List of Tables.

(7) List of Figures.

(8) List of Abbreviations.

(9) Sections.

(10) Appendices.

b. Input Form and Page Size. Originators of NAS documentation shall submit material in legible, typed form on standard 8-½ " x 11" paper with 7" x 9" image area.

c. Section Heads. Each section head shall begin on a new page separated from body text or sideheads with three line feeds. The section head shall be centered in full caps with three fixed spaces between number and title.

d. Primary Sideheads. Primary sideheads shall be typed flush left, in full caps, three fixed spaces between the number and the sidehead, and two line feeds before and after sidehead.

e. Secondary Sideheads. Secondary sideheads shall be typed flush left, initial caps, three fixed spaces between the number and the sidehead, and two line feeds before and after the sidehead. Full cap panel designations, acronyms, etc., shall remain all caps in the sidehead.

f. Tertiary Sideheads. Tertiary sideheads shall be typed flush left, initial caps, three fixed spaces between the number and the sidehead, a period after the sidehead, and two line feeds before the sidehead. Use two spaces after period and run in text on same line. Full cap panel designations, acronyms, etc., shall remain all caps in the sidehead.

g. Paragraphs. Paragraphs shall be single-spaced and blocked, with two line feeds before and after each paragraph.

h. Listings or Steps. Listings or steps shall be indented in multiple spaces of five, single-spaced, paragraph-blocked, with two line feeds before and after each item or step. Subordination shall be: a., 1., (a), (1).

i. Figure Titles. Figure titles shall be typed in full caps and centered below the figure. Multiple sheets shall be designated per example below. Runover lines shall be centered under first line. Figure number shall be Arabic prefixed by section number and separated by a dash.

Example: FIGURE 1-1. STANDARD TEST EQUIPMENT, INTERMEDIATE
SIDE VIEWS (SHEET 2)

j. Tables.

(1) Table Titles. Table titles shall be typed in full caps and centered on page above the table. Multiple sheets shall include the word (Continued) in initial caps in parentheses. Runover lines shall be centered under the first line.

(2) Column Heads. Column heads shall be typed in initial caps with the bottom rows aligned. Horizontal rules shall be drawn under column heads with the exception of complex tables which will require box rules. Horizontal rules for column heads shall not apply to originators supplying documentation on tape (see paragraph 9.).

(3) Oversize Tabular. Tables shall be oriented for minimum reduction. Type oversize and reduce to 7" width for vertical page or 8-1/2" x 6-1/2" for horizontal page.

k. Note, Caution, and Warnings. The words Note, Caution, and Warning shall be centered, full caps, standing alone on line with three line feeds before and two line feeds after. The body shall be blocked, single-spaced, and indented 12 fixed spaces on both sides.

APPENDIX IV

1. Footnotes. Single, double, and triple asterisks shall be used for footnotes. If additional notes are needed, single and double daggers shall be used. Digits may also be used for footnotes when required.

3.0 INPUT TEXT TAPE STANDARDS. Originators supplying text for NAS documentation on magnetic tape shall comply with the format specifications given in Input Hard Copy Standards, except that the nine-inch image length requirement shall not apply. NAS documentation will define page breaks during the editing process. In addition, the following requirements shall be satisfied:

a. The tape shall contain nine tracks at 800 bpi in DEC-10 ASCII format (see Table 3-1).

b. Fixed blocks of 128, 36-bit words, shall be used.

c. Each DEC 10 memory word is composed of five, seven-bit ASCII characters from left to right, with the 36th bit zero.

d. Each record within the block shall be terminated by an ASCII carriage return/line feed pair.

e. Records span blocks.

f. One 36-bit word requires five frames on nine-track tape (see Table 3-1).

g. Each tape shall contain no more than ten documents and each document shall end with a file mark.

h. The following commands shall be used to comply with the format requirements specified in paragraph 8. Special cases not discussed in paragraph 8., e.g., mathematical equations, shall be coordinated with NAS Documentation Facility at FAA Technical Center.

(1) The command [*ASCII] shall be used at the beginning of each document.

(2) The command/z shall be used for a carriage return (flush left) with no line feed.

(3) The command/l (lower case L) shall be used for a carriage return and line feed combination.

(4) The command/p performs the same function as two/l commands and shall be used at the end of each paragraph.

(5) The command^m (caret sign m) shall be used to advance one fixed character space.

(6) The command /c shall be used to center the text immediately preceding.

(7) The command /r shall be used to place the text entered after the last command flush right on the page.

APPENDIX IV

TABLE 3-1. NINE-TRACK TAPE FORMAT

	Frame 1	Frame 2	Frame 3	Frame 4	Frame 5
Track 1 (Parity)	ODD	ODD	ODD	ODD	ODD
2	0	8	16	24	Zero
3	1	9	17	25	Zero
4	2	10	18	26	30
5	3	11	19	27	31
6	4	12	20	28	32
7	5	13	21	29	33
8	6	14	22	30	34
9	7	15	23	31	35 (Zero)

(8) The command/u shall be used to advance horizontally to the next tab set.

(9) The command [van] shall be used to vertically advance n (an integer) points.

(10) The command [vrn] shall be used to vertically reverse n (an integer) points.

(11) The command [il#n] shall be used to indent n (an integer) spaces.

(12) The command [il0] shall be used to cancel the currently active [il#n] command.

(13) The entries ^/, ^+, ^[, and ^] shall be used where the characters /, +, [, and] respectively, are required.

(14) The command [ts#n_1, #n_2,....., #n_j] shall be used to set j (an integer) tabs of n_1, n_2,...etc., spaces.

(15) The command [ts] shall be used to cancel the currently active [ts#n_1, #n_2, ..., #n_j] command.

(16) The command [fb] causes the succeeding characters to be set in bold face type.

(17) The command [fr] cancels the currently active [fb] command.

4.0 INPUT HARD COPY GRAPHICS STANDARDS.

A. Graphics Standards. Unless stated otherwise, graphics shall conform to MIL-STD-100, Engineering Drawing Practices.

(1) Text Height. Standard text height for illustrations is 0.09" (ten-point type) in upper case. Lower case letters, mathematical symbols and signs Greek letters, subscripts, and superscripts may be used when required. Text height for titles is 0.157" (16 point type).

(2) Computer Program Flowcharts. All flowcharts shall be prepared on the following matrices:

5x10 matrix (11" x 17"). See Figure 3-1.

3x8 matrix (11" x 17"). See Figure 3-2.

6x14 matrix (11" x 17"). See Figure 3-3.

APPENDIX IV

(a) Flowchart Symbols. Standard flowcharting symbols shall be used. Most are shown in Figure 3-1. Others are contained in FAA Order 1370.14A CHG 1, Flowchart Symbol Standards, dated September 22, 1975.

(b) Alphanumerics. The alphanumerics for each block shall be kept to a minimum and limited to the size of the block to avoid spillover. Abbreviations shall be used wherever possible. The capacity of blocks varies with their size and shape. Figures 3-4, 3-5, and 3-6 show examples of the capacity of operational blocks, decision blocks, and offpage connectors for the 3x8, 5x10, and 6x14 matrices, respectively, for each of the two fonts used.

(c) Flow Direction. Flow direction is represented by lines between symbols. Normal direction of flow is from top to bottom and from left to right. Arrowheads are required to indicate reverse flow direction only. Where flow is bi-directional, arrowheads are used to indicate both normal and reverse direction flow. Flow lines shall intersect only where valid junctions are intended.

(d) Reproducible Flowchart Submissions. Flowcharts prepared in reproducible form shall contain lines which are opaque, 0.4mm (0.16") in width, and suitable for microfilming with a reduction of 24X.

(3) Logic, Wiring, and Schematic Diagrams. Wiring and schematic diagrams shall conform to ANSI Y14, American National Standard Drafting Manual.

(a) Diagram Symbols.

1 Logic Diagram Symbols. Graphic symbols used in electronics logic diagrams shall conform to ANSI Y32.14, Graphic Symbols for Logic Diagrams.

2 Wiring and Schematic Diagram Symbols. Wiring and schematic diagram symbols shall conform to ANSI Y32.2, American National Standard Graphic Symbols for Electrical and Electronics Diagrams.

(b) Reproducible Diagram Submissions. All line work prepared in reproducible form shall contain lines which are opaque, 0.4mm (0.16") in width, and suitable for microfilming with a reduction of 24X. Lettering may be typed or by lettering machine, but must be open, opaque, and fully legible so as to avoid loss and fade out in microfilming, reduction, or reproduction.

5.0 INPUT COMPUTER LISTING TAPE STANDARDS.

a. Listing Tape Standards. All computer listing print tapes shall be nine-track, 800 bpi, and have either ASA, 1401, or 360 standard carriage control formats with blocking factor not to exceed ten.

b. Tape Identification. Tapes shall be submitted with labels specifying the title, type of listing, and specific instructions defining which data to place in the index frame of the microfiche.

c. Output Microfiche Format. The tape will be run on the COM system for microfiche output in a 48X standard vertical paginated format (270 frames per fiche) as specified in FAA Order 1350.21, FAA Microform Standards, dated September 1, 1977.

APPENDIX IV

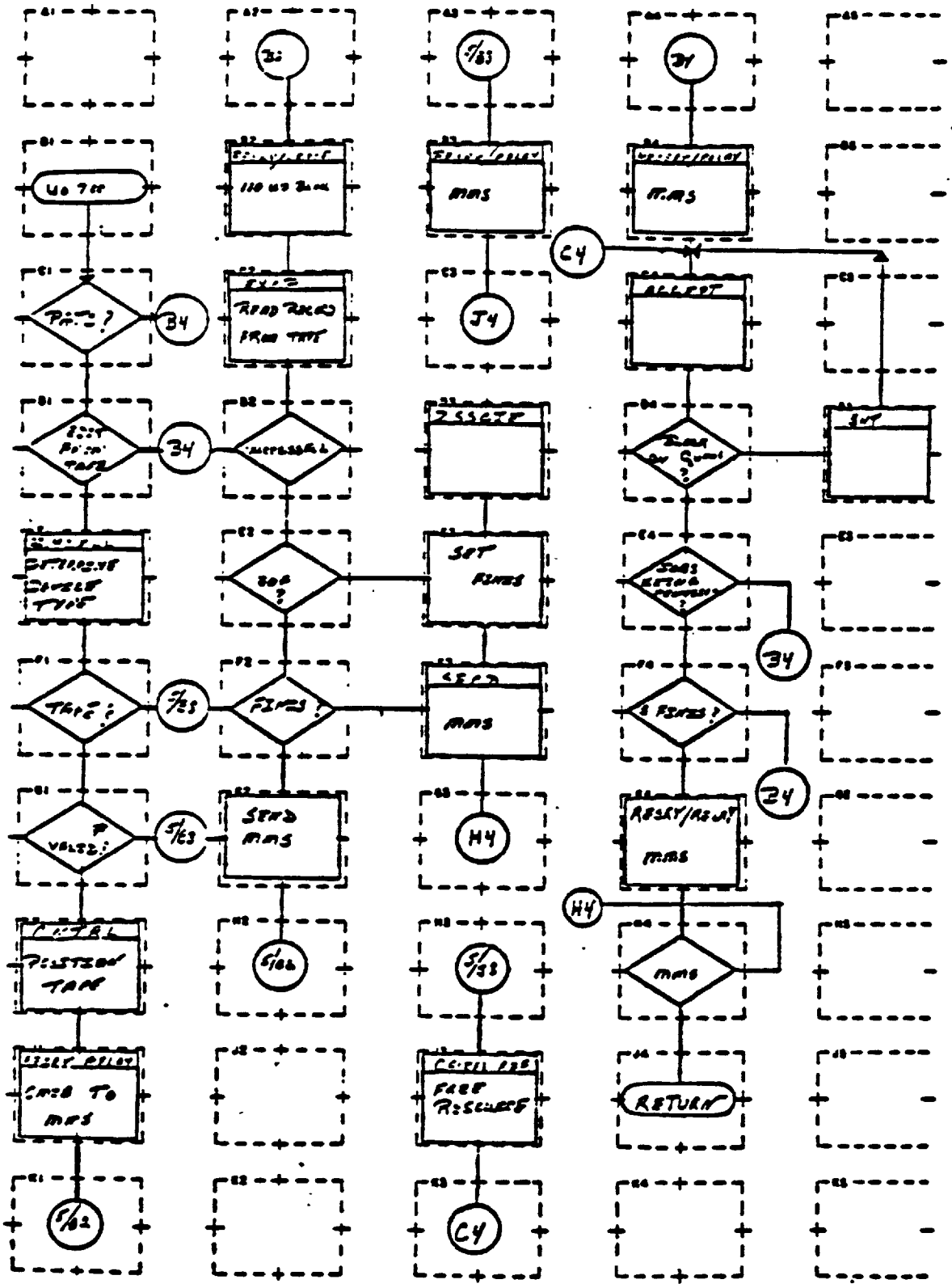

FIGURE 3-1. 5 X 10 FLOWCHARTING WORKSHEET

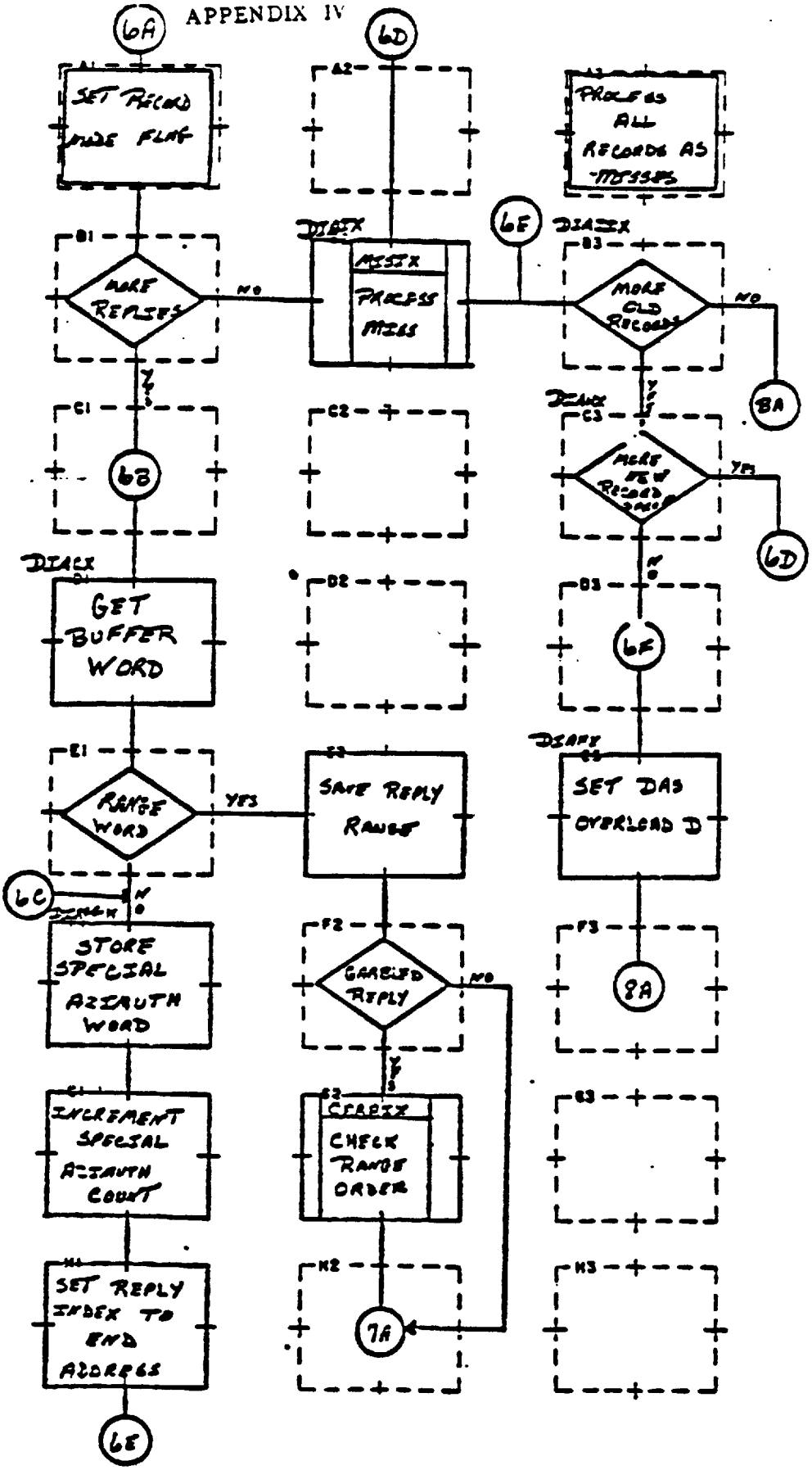

FIGURE 3-2. 3 :: 8 FLOWCHARTING WORKSHEET

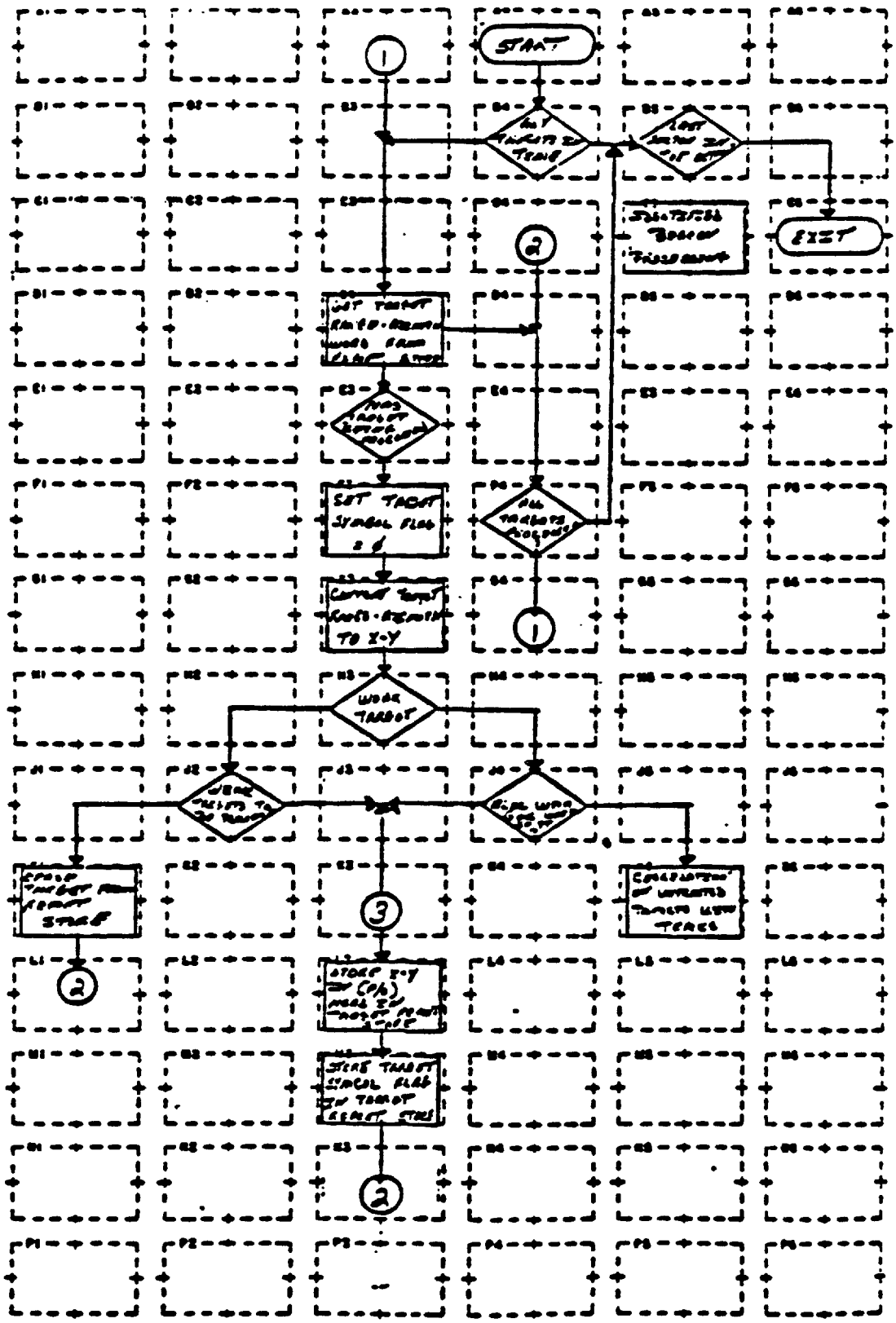

FIGURE 3-3. 6 X 14 FLOWCHARTING TECHNIQUE

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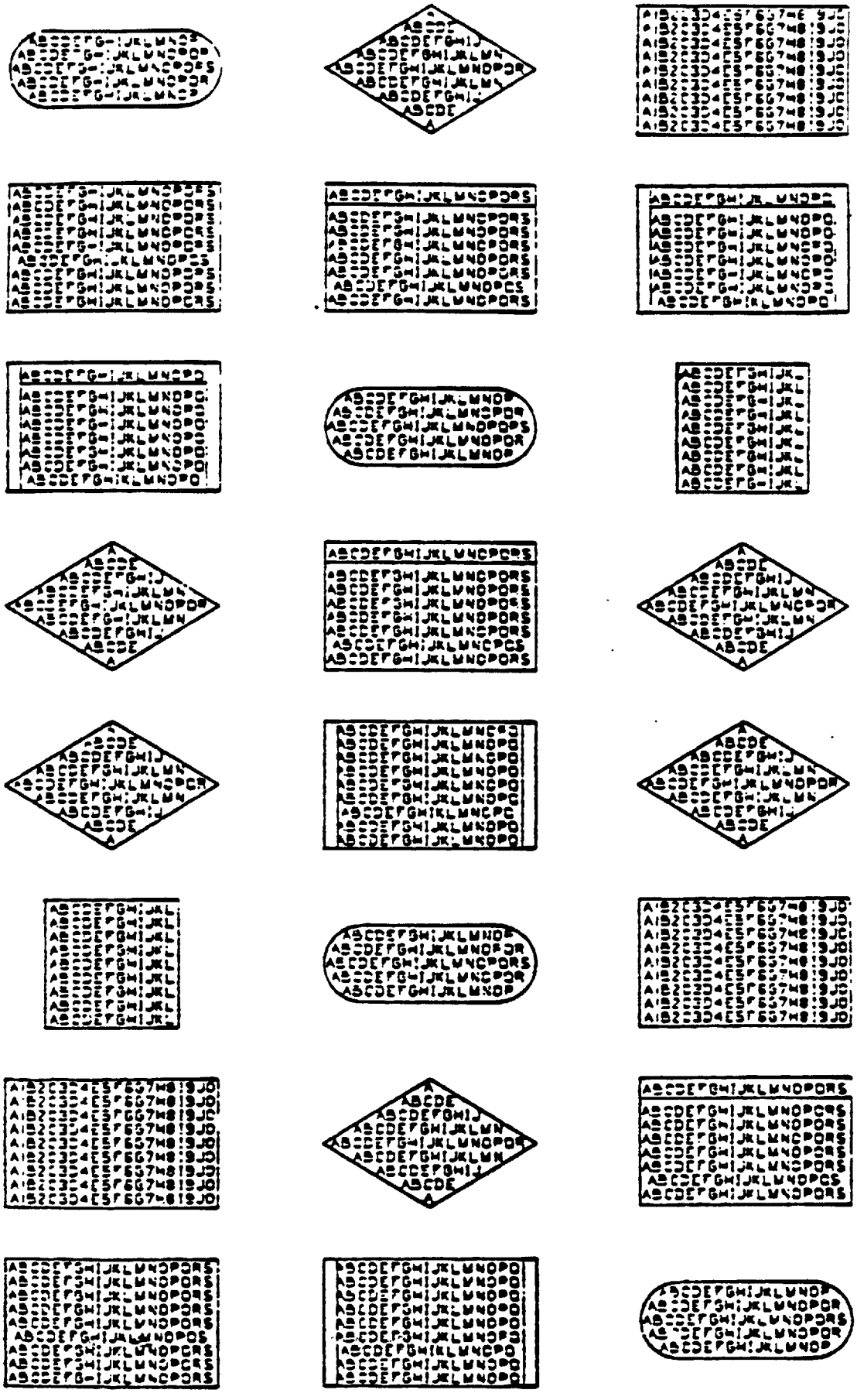

FIGURE 3-4. 3 X 8 MATRIX, USING FONT 3 (SHEET 1)

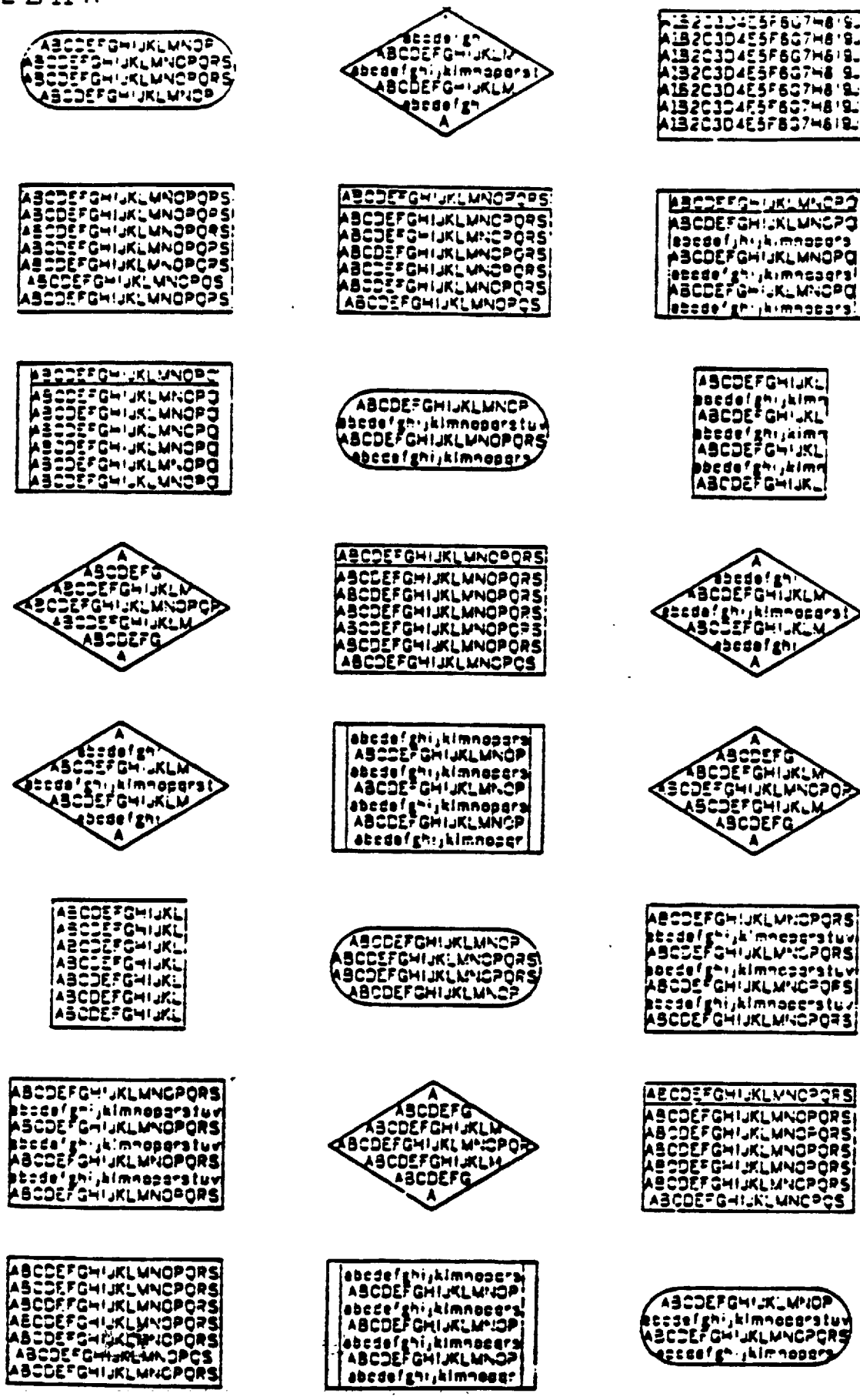

FIGURE 3-4. 3 X 8 MATRIX, USING FONT 5 (SHEET 2 - END)

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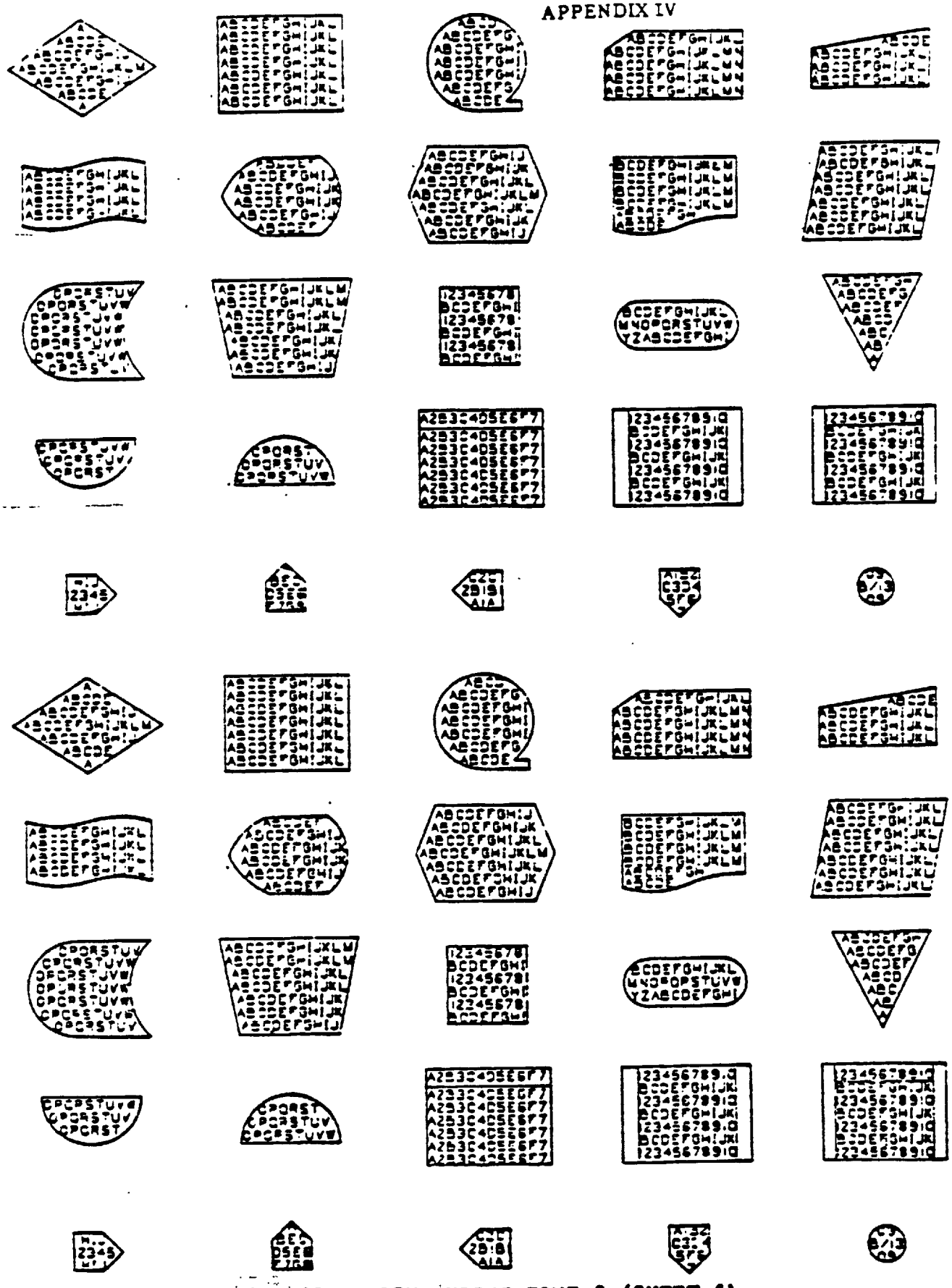

FIGURE 3-5. 5 X 10 MATRIX, USING FONT 3 (SHEET 1)

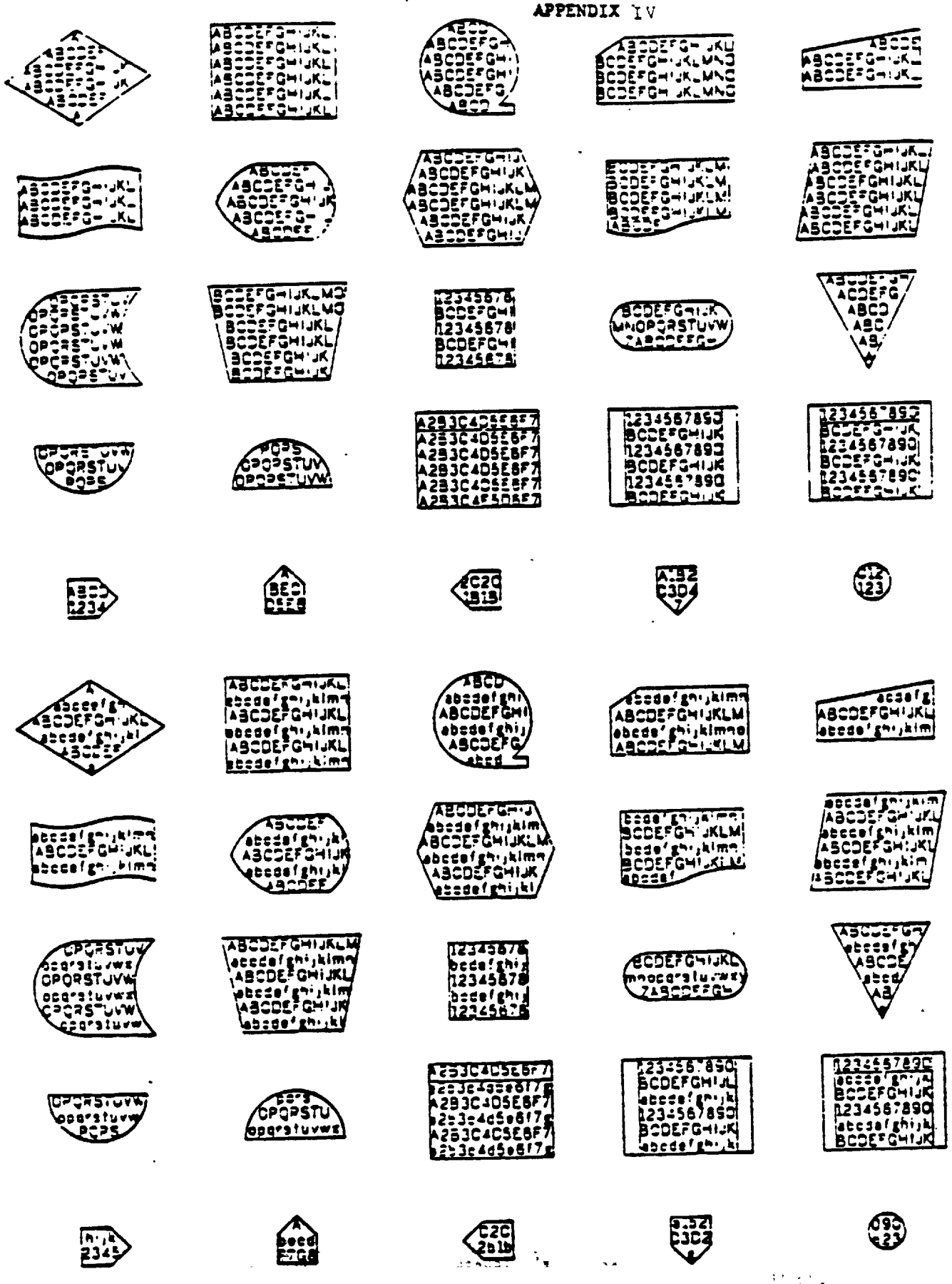

FIGURE 3-5. 5 X 10 MATRIX, USING FONT 5 (SHEET 2 - END)

APPENDIX IV

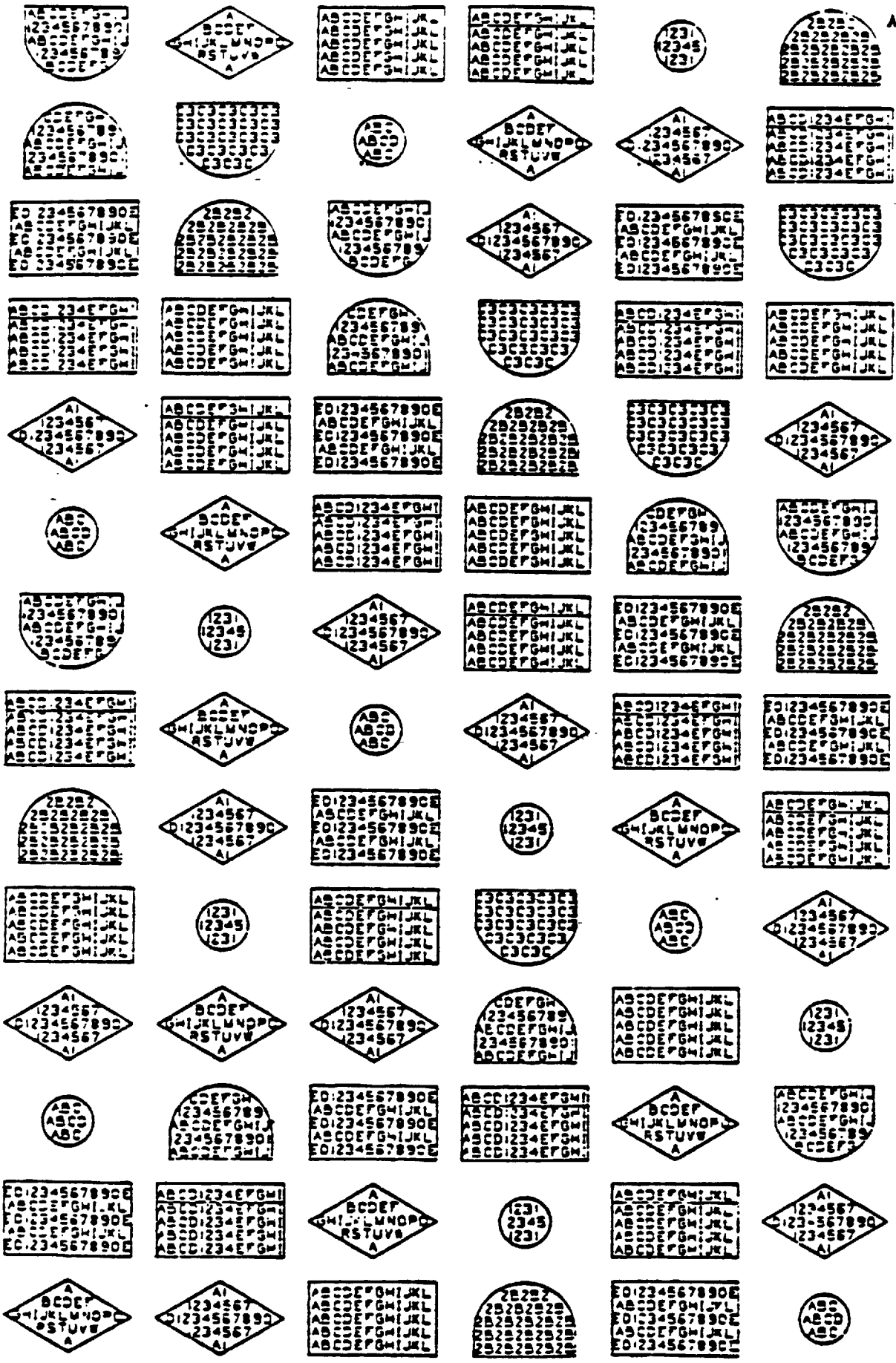

FIGURE 3-6. 6 X 14 MATRIX. [illegible]

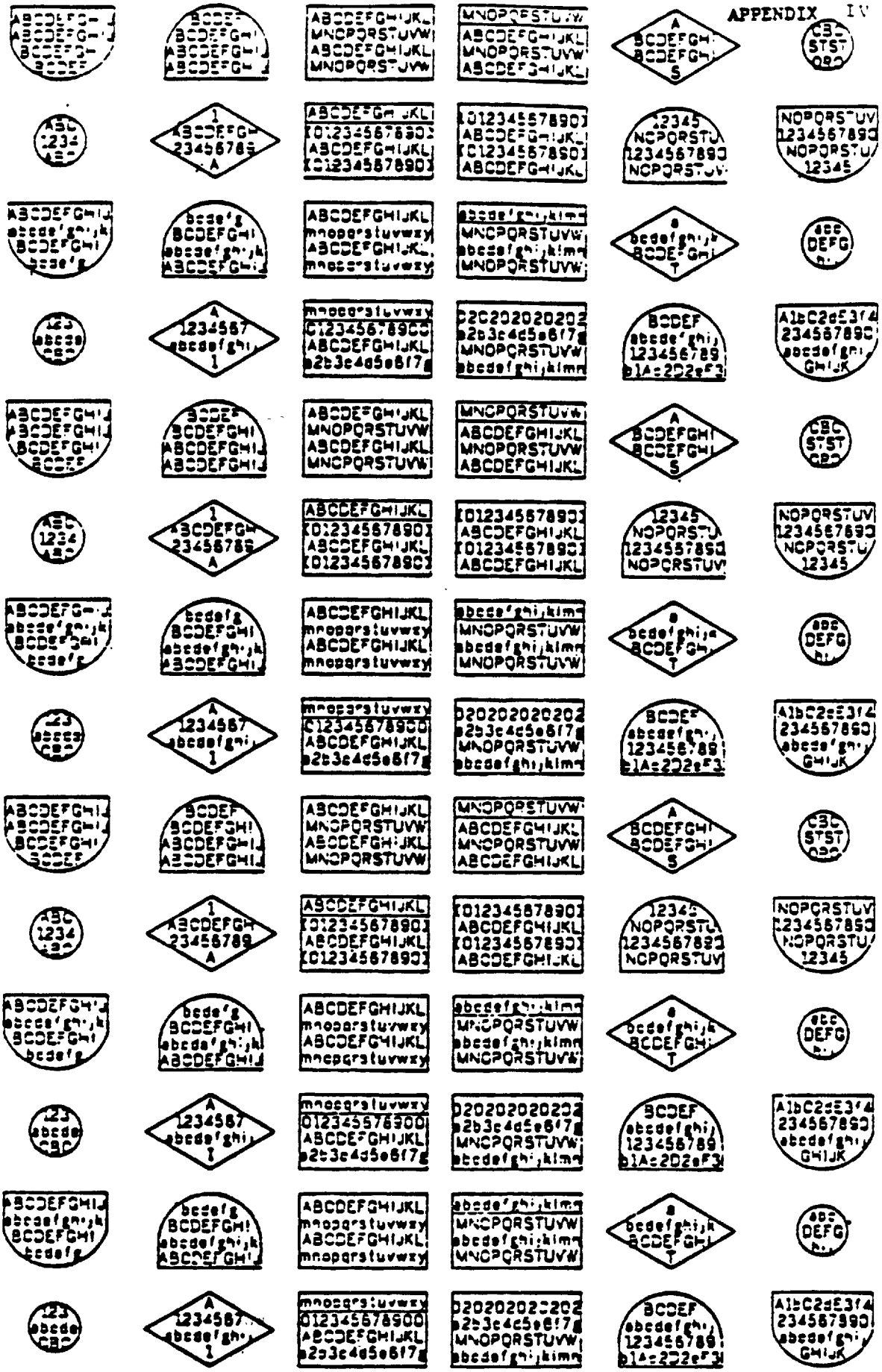

FIGURE 3-6. 6 X 14 MATRIX, USING FONT 5 (SHEET 2 - END)

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APPENDIX IV

6.0 INPUT HARD COPY TEXT STANDARDS

a. Miscellaneous.

(1) Foldouts. Pages large enough to require foldouts are not compatible with the current automatic processing equipment and therefore, cannot be produced on microfiche. Originators requiring foldouts shall contact ACT-765 prior to document submission to allow special arrangements to be made.

(2) Page Numbering. Pages shall be numbered in Arabic prefixed by the section number and placed right and left, e.g., 1-1, 1-2, 2-1, 2-2, 2-3.

(3) Change Pages. If 40 percent or less of a document has changed, a hard copy change package, including a notice sheet and instructions, may be produced, however, microfiche of the complete document shall be made. The current change shall be noted by a change bar shown on the right margin of the text. Since page numbering is done automatically, change page packages may contain many more pages than were changed technically.

(4) Halftones and Photographs. Halftones and photographs shall not be used unless absolutely necessary. They are not compatible with the current automatic processing equipment. Originators requiring halftones or photographs shall contact ACT-765 prior to document subrission to allow special arrangements to be made for digitizing the illustrations.

NAME	TEL #
Information Handling Services 1700 North Moore Street Arlington, Virginia 22209 Attn: Charlie Sobel	524-0602
International Computerprint Corporation 475 Virginia Drive Fort Washington, Penna. 19034 Attn: Paul Piombino	215/641-6015
SOGITEC Inc. 1875 I Street NW Suite 960 Washington, D.C. 20006 Attn: Duane Widerman	293-7955
Micro Tech Industries 1301 Dairy Street Philadelphia, Penna. 19124 Attn: Marie Schroth	215/533-5300
APC Graphics 1125 Walnut Street Philadelphia, Penna. 19107 Attn: Joe DeFinis	215/922-3131
PRC Image Data Systems Co. 7600 Springhouse Road McLean, Virginia 22102 Attn: Joseph L. Hughes	893-1800
Graphic Data Inc. Fellowship Road and West Park Drive Mount Laurel, New Jersey 08054 Attn: Ken Margulies	609/778-1560 NJ
Raytheon Company 528 Boston Post Road Sudbury, Massachusetts 01776 Attn: Joseph Z. Cooper Walter D. Batt	617/443-9521
Tymshare Inc. 1500 Wilson Blvd. Arlington, Virginia 22209 Attn: Duane Stone	
Sun Information Services 680 East Swedesford Road Suite 310 Wayne, Penna. 19087 Attn: Jack Scott	215/293-0660
Princeton Data Film P. O. Box 251 Princeton Junction, New Jersey 08550 Attn: John Posada	609/799-1630

APPENDIX V

DATA ITEM DESCRIPTION	IDENTIFICATION NO(S)	
	AGENCY	NUMBER
1 TITLE REPORT, RELIABILITY STATUS	NAVY	DI-R-2119
3 DESCRIPTION/PURPOSE This report keeps the procuring activity aware of the progress of the reliability effort.	4 APPROVAL DATE 1973 August 28	
	5 OFFICE OF PRIMARY RESPONSIBILITY (& USERS) OS (AS, EC, SH)	
	6 DDC REQUIRED N/A	
7 APPLICATION/INTERFACE Quantitative reliability requirements must be specified for the end item. These requirements are allocated to each unit of the hardware breakdown structure. Predictions and tests are then to be performed in order to verify that the quantitative requirements and allocations have been met. A report is then prepared and submitted describing the reliability program so that there is a schedule by which program and status can be measured.	7 APPROVAL LIMITATION N/A	
	8 REFERENCE(S) (SOURCE OF DATA IN BLOCK 10) MIL-STD-750 MIL-STD-785 MIL-STD-883 MIL-STD-847 MIL-STD-1304(AS) MIL-HDBK-217	
	9 MSSL NUMBER 30440.20328	

10 PREPARATION INSTRUCTIONS

10.1 Unless otherwise indicated herein, documents cited in this block of the issue in effect on the date of invitation for bids or request for proposals or quotations form a part of this Data Item Description to the extent specified herein.

10.2 Reliability Status Report. This report shall consist of a reliability management summary, a reliability schedule problem narrative, and a reliability trend summary.

10.2.1 Reliability Management Summary. This shall include an enumeration of the work packages scheduled to be in process or actually in process during the reporting period and the work packages scheduled to be in process during the next reporting period. The enumeration of work packages shall show the time status of each work package indicating:

a. The scheduled starting date

b. The actual starting date

c. The scheduled completion date

d. The actual completion data.

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DI-R-2119

10. PREPARATION INSTRUCTIONS (Continued)

10.2.2 Reliability Schedule Problem Narrative. This shall be presented in concise narrative form and may be supplemented by graphs to highlight significant trends, developments, and factors. The topics to be discussed shall include but are not limited to:

10.2.2.1 Outlook: The overall outlook shall be analyzed in relation to the current dates and latest revised reliability estimates for the end item requirements and also in relation to previous outlooks. Reasons for major differences between the current and preceeding outlooks shall be analyzed in terms of important intermediate objectives which precede the ending event.

10.2.2.2 Problem areas and corrective action. All major problem areas disclosed by analysis of important intermediate objectives or by deviations of latest revised estimates from reliability requirements shall be identified to the summary number; and the action taken, or solutions proposed, shall be reported. This section shall cover actions that the contractor is taking to avoid slippages and recommendations for Government action. Problem areas reported previously shall be carried forward until rectified.

10.2.3 Reliability trend summaries. This summary shall include a set of figures similar to Figure 1. These figures shall show the allocated,predicted, and demonstrated reliability characteristics for the current and previous trend summaries.

10.2.3.1 Demonstrated reliability. The value of demonstrated reliability to be shown shall be based on the cumulative results of tests to date for the item in the then current configuration.

10.2.3.2 Predicted reliability. The value of predicted reliability to be shown shall be a synthesis of the predicted or demonstrated reliability of the items at the next lower level of assembly.

10.2.3.3 Allocated reliability.

10.2.3.3.1 End Item. For the end item, the overall design requirement shall be shown.

10.2.3.3.2 Subordinate items. The allocated value of the end item overall design requirement shall be shown.

10.3 Format. This report shall be prepared in accordance with MIL-STD-847.

10.4 Changes. When changes are made to the end item, this report shall be supplemented with revision material to reflect the change. Revised material shall bear the same page numbers as those pages which are to be replaced, plus the word "revised" and the date of revisions. Additional pages shall bear the same page number as the preceding page followed by a lower case letter unless the additional pages follow the last page of the report. Revised or

10. PREPARATION INSTRUCTIONS (Continued)

added material shall include a revised title page indicating the date of the revision. The revised title page shall contain the information contained on the original title page plus a revised index of revisions.

10.5 Naval Electronics Systems Command Option: The Report, Reliability Status shall contain the following information:

a. A complete accounting of progress on all tasks required to be performed by the reliability program plan.

b. All details of additions, deletions, or changes to the tasks defined by the reliability program, scope of effort, milestones, key personnel, procedures, or organization with a brief discussion of why these additions, deletions, or changes are required.

c. A complete account of results achieved for each task defined by the reliability program.

d. Identification of all problems affecting design, schedule and reliability along with proposed solutions and solutions implemented since the last report. An estimate of scope of effort and completion date shall be included for each problem.

e. The number of man hours allocated to the reliability program plan. No special accounting procedures are required. The results of the contractors own planning system, such as Gantt charts, Pert Charts, etc. may be used.

f. A cumulative listing of man hours spent on the program as of the date of the current report including name and labor grade. No special accounting procedures are required. The results of the contractors own accounting system may be used.

g. Reliability requirements imposed on subcontractors and suppliers and reports on any surveillance of subcontractors or suppliers activities in the periodic report immediately following the imposition of the requirement or following the surveillance.

h. Notification of contractually scheduled program reviews with agenda. The minutes of the program review shall be included in the periodic report immediately following the program review.

i. Any failure rate data obtained from sources other than MIL-HDBK-217. Enough information in support of the failure rate data must be included in the periodic report for the procuring activity to evaluate the validity and applicability of the data. This data must be submitted no later than the periodic report immediately following the acquisition of the data.

j. The documented results of design reviews shall be included in the periodic report immediately following the design review.

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10. PREPARATION INSTRUCTIONS (Continued)

k. When a component that has been subjected to special screening techniques (such as X-Ray, MIL-STD-750 tests, MIL-STD-883 tests, etc. for the purpose of enhancing reliability or claiming lower failure rates) fails prior to incorporation into an assembly, the failure shall be reported and analyzed in accordance with the paragraph "Failure Data Collection, Analysis, and Corrective Action" of MIL-STD-785 and the approved reliability program plan. All of the data pertinent to the specific screening techniques shall be included in the first periodic reliability report subsequent to the occurance of the failure.

10.6 Naval Air Systems Command Option. The content of this report shall be in accordance with MIL-STD-1304(AS). The format of this report shall be in accordance with MIL-STD-847. Change material shall be in accordance with 10.4.

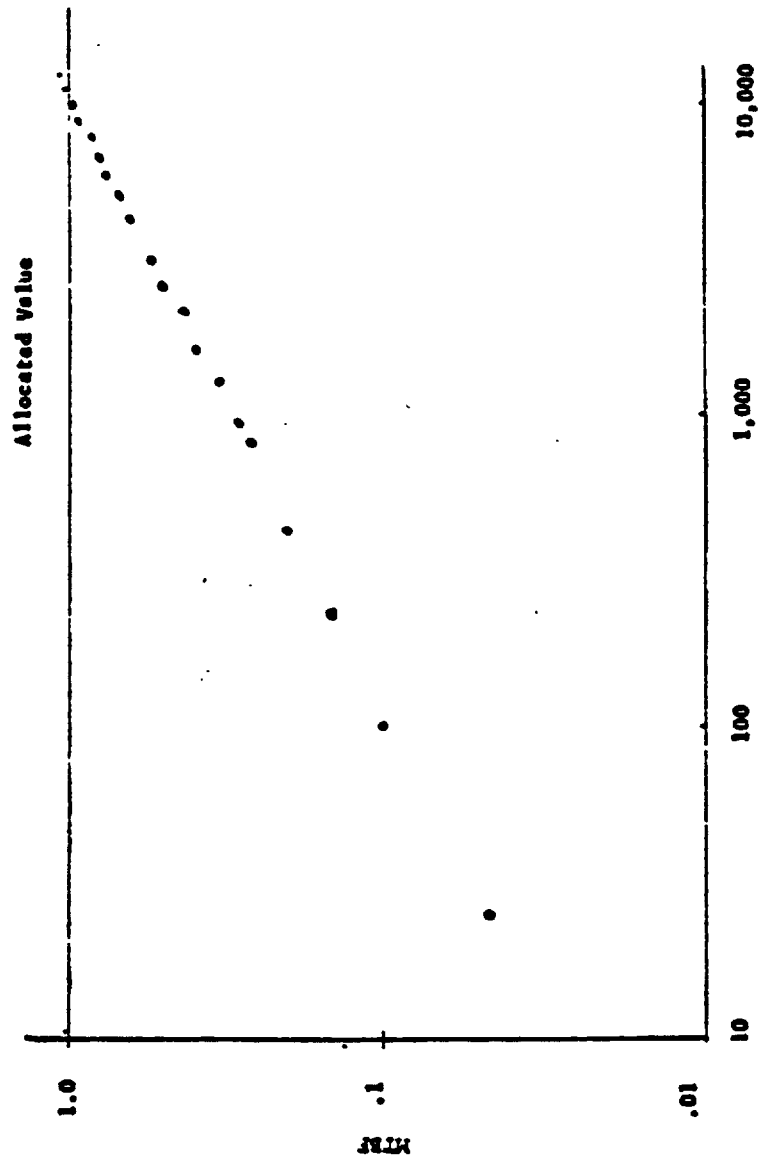

Figure 1 RELIABILITY GROWTH SUMMARY FOR WORK
Time (Hours)

APPENDIX VI

DATA ITEM DESCRIPTION	2. IDENTIFICATION NO.
1. TITLE REPORT, RELIABILITY AND MAINTAINABILITY ALLOCATIONS, ASSESSMENTS, AND ANALYSIS	AGENCY: NAV-SHIPS NUMBER: UDI-R-23570
3. DESCRIPTION/PURPOSE This report is used by the procuring activity to (1) evaluate the contractor's estimate of reliability and maintainability (the predicted growth, allocation, and degree of achievement of these characteristics in the contract end item and its constituent elements); (2) evaluate the current and potential reliability and maintainability of the contract item design; (Cont'd. on next page)	4. APPROVAL DATE 72 APRIL 01 5. OFFICE OF PRIMARY RESPONSIBILITY SHIPS 0125 6. DOC ASSIGNED 6. APPROVAL LIMITATION
7. APPLICATION/INTERFACE This Data Item Description is applicable during the contract definition and acquisition phases and equipment contracts for complex equipments through the end of testing. It may also be used to define information to be submitted in response to a request for proposal.	8. REFERENCES (Mandatory as cited in Block 10) MIL-STD-470 MIL-STD-721 MIL-STD-756 MIL-STD-785 MIL-HDBK-217 MIL-HDBK-472 NAVSHIPS-93820 9. DOD NUMBERING

10. PREPARATION INSTRUCTIONS

1. The referenced documents (block 9) in effect on the data of invitation for bid or request for proposal form a part of this DID to the extent specified herein.

2. This report shall contain as a minimum, the following information:

a. Contractor's analysis of reliability and maintainability potential of the contract item design, including mathematical models, logic diagrams, functional block diagrams, assumed operating conditions, environmental criteria and other related considerations used in accomplishing the calculations.

b. Full disclosure of the equipment breakdown, including identification of the component parts affected (by name, part number, work unit code, Federal stock code and other standard designators when possible), failure rates, repair rates, holding time (and other time factors), assumed equipment usage, maintenance doctrines, conditions utilized in the analysis, and a comparison with his allocation.

c. Analysis of potential modes of failures; their probable cause and effects on performance, reliability, and maintainability. The severity of these effects and the probability of occurrence per the severity classification under applicable operating modes and environments shall be indicated. The degree of protection afforded by the design against the occurrence of the failures or their adverse results shall be specified.

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DATA SET CONTINUATION SHEET

TITLE	CONTROL NO
REPORT: RELIABILITY AND MAINTAINABILITY ALLOCATIONS, ASSESSMENTS, AND ANALYSIS	UDI-R-23570

Description/Purpose - Continued

(3) provide information to assist in directing and planning and allocation of resources for reliability and maintainability and related program efforts; and (4) identify design features which are deemed critical with respect to reliability and maintainability.

10. Preparation Instructions - Continued

d. Description of the purpose and function of the applicable items.

e. A description of trade studies involving reliability, maintainability, and other factors and the resulting effects on overall system effectiveness. Trade studies shall be made available at the request of the procuring activity to substantiate and expand the results.

f. Effects of storage, shelf-life, packaging, transportation, handling, and maintenance on the reliability of the product. Major or critical characteristics of items which deteriorate with age should be included, plus environmental limits, maintenance philosophy, and equipment usage.

g. The contractor's conclusions, identification of problem areas, and related actions taken or proposed as a result of the analyses. A list of further design studies planned as a result of these analyses shall be included.

h. The contractor's allocations of the overall quantitative goals and minimum requirements for contract item reliability and maintainability specified by the procuring activity or developed by the contractor, as applicable, to lower indenture items down to the level specified in the contract or, in the absence of such specification, to the lowest level of contract item breakdown deemed appropriate by the contractor. As a general rule, this breakdown should be carried to the level at which failure reports will be submitted.

i. Current observed achievement of reliability or maintainability of the contract item and its constituent elements to the lowest practical level of indenture. In each case, the type and units of measurement shall be clearly identified (e.g., MTBF in hours, MCBF, MTTR active time, MTTR, mean man-hours, MTBM, availability, probability of satisfactory performance, percent successful, etc.) Confidence levels or intervals shall be stated where appropriate. Achieved and predicted reliability growth curves shall be included. A comparison with the analysis and allocation for the contract item shall be included. Where multiple tests are conducted to assess reliability, methods of combining data and confidence limits shall be discussed.

j. An estimate or measure of end item reliability.

k. An estimate or measure of end item maintainability.

APPENDIX VII

DATA ITEM DESCRIPTION	2 IDENTIFICATION NO(S): AGENCY	NUMBER
1 TITLE: PLAN, RELIABILITY PROGRAM	NAVY	DI-R-2113
3 DESCRIPTION/PURPOSE: This document serves as basic documentation of the contractor's planning of the Reliability Program to be conducted for the applicable contract items. The plan is used by the procuring activity to effect initial review and approval of the contractor's Reliability Program and as the basis for monitoring and evaluating the contractor's conduct and as the basis for monitoring and evaluating the contractor's conduct of the program.	4 APPROVAL DATE: 1973 August 29	
	5 OFFICE OF PRIMARY RESPONSIBILITY (& USERS): OS (AS, SH, Ec)	
	6 DDC REQUIRED: N/A	
7 APPLICATION/INTERFACE: This Data Item Description is applicable during contract definition and acquisition phases and equipment procurement contracts when contractors are to conduct reliability programs in accordance with MIL-STD-785. This plan may be obtained either precontractually (during the RFP/RFQ/IFB phase) or as a product of the definition phase and updated during the acquisition phase or prior to production phase.	8 APPROVAL LIMITATION: N/A	
	9 REFERENCES (SOURCE OF SHALL BE USED): MIL-STD-785 MIL-STD-847 MIL-STD-1304(AS)	
	10 END ITEM NUMBER: 30440,20328	

10 PREPARATION INSTRUCTIONS

10.1 Unless otherwise indicated herein, documents cited in this block of the issue in effect on the date of invitation for bids or request for proposals or quotations form a part of this Data Item Description to the extent specified herein.

10.2 The reliability program plan shall be prepared in accordance with MIL-STD-785, paragraph 4.4.

10.3 Format. This report shall be in general accordance with MIL-STD-847.

10.4 Naval Electronic Systems Command Option: The reliability program plan shall address all paragraphs of MIL-STD-785 in accordance with the guidance given for the applicable paragraphs both in MIL-STD-785 and this data item description. Where no guidance is given in this data item description, it is felt that guidance given in MIL-STD-785 is sufficient for the preparation of that portion of the data item:

a. General Requirements -

b. Detailed Requirements -

(1) Reliability Organization - In addition to the guidance given in this paragraph the following topics will be discussed:

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DI-R-2113

10. PREPARATION INSTRUCTIONS (Continued)

(a) The organization of reliability effort within the organization to achieve minimum requirements at minimum cost and effort;

(b) Controls required to implement these objectives;

(c) Appropriate functions throughout organization responsible for implementing its policy and procedures;

(d) Systems for management follow-up and evaluation;

(e) Identify key personnel by name and function and submit resumes. List the staff adequate to implement program and what protion of time each will devote to the program;

(f) Cost management system within the reliability organization;

(g) Cost records (scrap, rework, testing, etc.);

(h) Vendor selection and control including review and approval of purchase specifications;

(i) Means by which responsibility will be delegated;

(j) System for design surveillance;

(k) Reliability Group to be actively involved in program scheduling;

(l) Point in the program when production department will get involved in program;

(m) Method for instituting corrective action;

(n) Clearly defined reliability group including authority responsibilities, functions, policy and actions;

(o) The authority of the organization to enforce its policies within the organization;

(p) Relationship to other groups in the organization;

(q) System of dwg review and approval;

(r) Engineering design change review procedure;

10. PREPARATION INSTRUCTIONS (Continued)

(s) Methods of control of subcontractors and supplier;

(t) Means of indoctrinating and training all personnel (production, purchasing, test, engineering, etc.) with respect to any special policy and procedures required for this specific program in order to assure achievement of reliability requirements.

(u) System, equipment and/or component burn-in program.

It is not intended that all of the minute details of accounting procedures, drawings control procedures, etc., be included in the reliability program plan but enough information shall be provided (such as document control numbers, policy statement numbers or titles, etc.) for the procuring activity to know where or who to go to for further information if desired.

(2) Management Tasks - In regard to this paragraph of MIL-STD-785 a task is defined as any element of work to be performed by the contractor which is specified in the reliability program plan, equipment specification, contract, or is identified by the contractor in correspondence with the procuring activity as a work effort which has to be performed.

(3) Reliability Interface Compatibility - The plan shall identify and define interfaces between the Reliability Program and the closely related programs or elements, such as:

(a) Maintainability Program;

(b) Integrated Logistics Support;

(c) Personnel Subsystem/Human Engineering/Safety Program;

(d) Systems Engineering;

(e) Sustems/Cost Effectiveness Analysis;

(f) Design Engineering;

(g) Value Engineering;

(h) Data Collection and Analysis Procedures;

(i) Quality Control Program;

(j) Component Engineering.

(4) Subcontractor and Supplier Reliability Programs - The reliability program plan shall describe how the contractor will monitor the efforts of subcontractors and suppliers and how definitive and objective criteria for acceptance or rejection of suppliers products will be established and involved in subcontracts and purchase specifications.

DI-R-2113
10. PREPARATION INSTRUCTIONS (Continued)

(5) Program Review - The plan shall include provisions for furnishing an agenda for the program review and shall be included in the notification to the procuring activity.

(6) Design Techniques -

(7) Reliability Analysis - The program plan shall describe how trade-offs are to be made among effectiveness, schedule, cost and other resources and shall not be established unilaterally by the contractor if the trade-offs would require that some of the equipment/systems specifications be compromised. Any decision by the contractor which would compromise reliability requirements would be considered a change in scope for the reliability program and would have to be reflected in the reliability program plan and have the concurrence and approval of the contracting officer. The data item description for reliability prediction reports shall be used for these portions of this paragraph relating to reliability predictions.

(8) Model Inputs -

(9) Functional Model -

(10) Reliability Apportionment/Prediction -

(11) Model Outputs -

(12) Model Updating -

(13) Parts Reliability - Special vendor or in-house component tests and/or screening procedures.

(14) Failure Mode and Effect Analysis (FMEA) -

(15) Reliability Critical Items -

(16) Effects of Storage, Shelf-life, Packaging, transportation, handling, and Maintenance -

(17) Design Reviews -

(18) Reliability Test Plans -

(19) Development Testing -

(20) Reliability Demonstration - The following additional topics shall be addressed under this paragraph:

(a) Assessment of the cost of testing with respect to the desgree of assurance to be attained;

(b) Accumulation of other program test information and their value in determining reliability;

10. PREPARATION INSTRUCTIONS (Continued)

(21) Failure Data Collection, Analysis and Corrective Action -

(22) Transition from Development -

(23) Reprocurement -

(24) Status Reports - The program plan shall address reliability status reports.

10.5 Naval Air Systems Command Option: The content of this report shall be in accordance with MIL-STD-1304(AS). The format of this report shall be in accordance with MIL-STD-847. When changes are to be made to the end item, this report shall be supplemented with revision material to reflect the change. Revised material shall bear the same page numbers as those pages which are to be replaced, plus the word "revised" and the date of revisions. Additional pages shall bear the same page number as the preceding page followed by a lower case letter unless the additional pages follow the last page of the report. Revised or added material shall include a revised title page indicating the date of the revision. The revised title page shall contain the information contained on the original title page plus a revised index of revisions.

★ U. S. GOVERNMENT PRINTING OFFICE: 1973 - 715-144/1213

APPENDIX VIII

DATA ITEM DESCRIPTION	2. IDENTIFICATION NO.
1. TITLE: Procedures, Reliability Tests	AGENCY: DOD / NUMBER: DI-R-7035
3. DESCRIPTION/PURPOSE: The reliability test procedures provide detail technical directions for implementing the approved Reliability Test Plan. The procedures contain step-by-step instructions of how the equipment involved in the test, e.g., the units under test, the test chambers, and the monitoring equipment, will be utilized during the reliability qualification and acceptance tests.	4. APPROVAL DATE: 21 October 1977 5. OFFICE OF PRIMARY RESPONSIBILITY: Navy 6. DTIC REQUIRED: 7. APPLICATION/LIMITATION:
8. APPROVED REFERENCES (Mandatory as cited in Block 10): MIL-STD-781C	
9. APPLICATION/INTERRELATIONSHIP: Reliability Test Procedures are normally required for all contracts which require reliability or production acceptance tests. These documents are generally used by the procuring activity for review and approval of the contractor's procedures for conducting reliability tests, and in the subsequent surveillance of the tests and evaluation of the results. This Data Item Description replaces UDI-R-20453, UDI-R-20454, and UDI-T-23710 under MIL-STD-781B of 15 November 1967.	11. DTIC NUMBERS: AMSC 22333

10. PREPARATION INSTRUCTIONS

10.1 The test procedures shall conform to the technical requirements of MIL-STD-781C as specified by the Contract. The detail requirements for the content of reliability qualification and acceptance test procedures are listed below.

10.2 CONTENT

a. A list and brief description of all units comprising the equipment and a specific listing of those units which will be placed on test and the up-to-date configuration (drawing list including approved changes, waivers and deviations).

b. Test and monitoring equipment to be used, including manufacturer and model number and time meter requirements.

c. Test equipment calibrations requirements.

d. Graphical presentation of the required thermal survey of the equipment made prior to start of testing, with narrative and analysis leading to establishment of monitored temperature stabilization points (if available when the test procedures are prepared).

e. Burn-in requirements and environment to which equipment shall be exposed prior to test.

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DI-R-7035 (Continued)

10. PREPARATION INSTRUCTION (Continued)

f. The levels and tolerances for time, temperature and other details of the combined stress environmental cycle, including the duty cycle, moisture, vibration stress and duration, and input voltage.

g. Allowable adjustments and normal checkout procedures for the equipment under test.

h. Preventive maintenance measures to be performed during the test, if such maintenance is permitted by the detailed equipment specification.

i. Performance parameters to be measured, frequency of measurement, method and under what environmental conditions.

j. Performance parameter limits beyond which a failure has occurred.

k. Failures classified as nonrelevant.

l. Data to be recorded during tests and samples of report or log forms to be used. (See 10.3)

m. Any computer software used in the test.

n. List of any Government Furnished Equipment to be used during test.

o. Action to be taken if a reject decision is reached, including corrective action plan and retest provisions.

p. Whether testing will be continuous or interrupted by work shifts.

q. Interconnecting cable diagrams of complete test set-up including equipment under test and test monitoring equipment.

10.3 Test Records. The test records described in the following paragraphs shall be used to prepare data resulting from reliability tests. Equivalent contractor data record formats are acceptable, when approved by the procuring activity.

10.3.1 Test Log and Data Record. The test log and data record is a complete record of required test data for each unit under test and shall be maintained throughout the test. Figure 1 may be used as a guide for the test log sheet.

10.3.2 Equipment Failure Record. The failure record for each equipment is designed to permit keeping of the entire test history of each tested equipment on a single sheet. The failure record may be organized as in Figure 2.

DI-R-7035 (Continued)

10. PREPARATION INSTRUCTIONS (Continued)

10.3.3 Failure Summary Record. The failure summary record is intended to contain all the information needed to reach an accept/reject decision on the test sample. The failure summary record may be organized as in Figure 3.

10.3.4 Failure Tag. Figure 4 is a sample of the failure tag that is required for each failed unit.

10.3.5 Failure Report. Data for each equipment failure, failure analysis, and corrective action shall be recorded on report forms similar to the examples of Figure 5, Sheets 1 through 4.

DI-R-7035 (Continued)

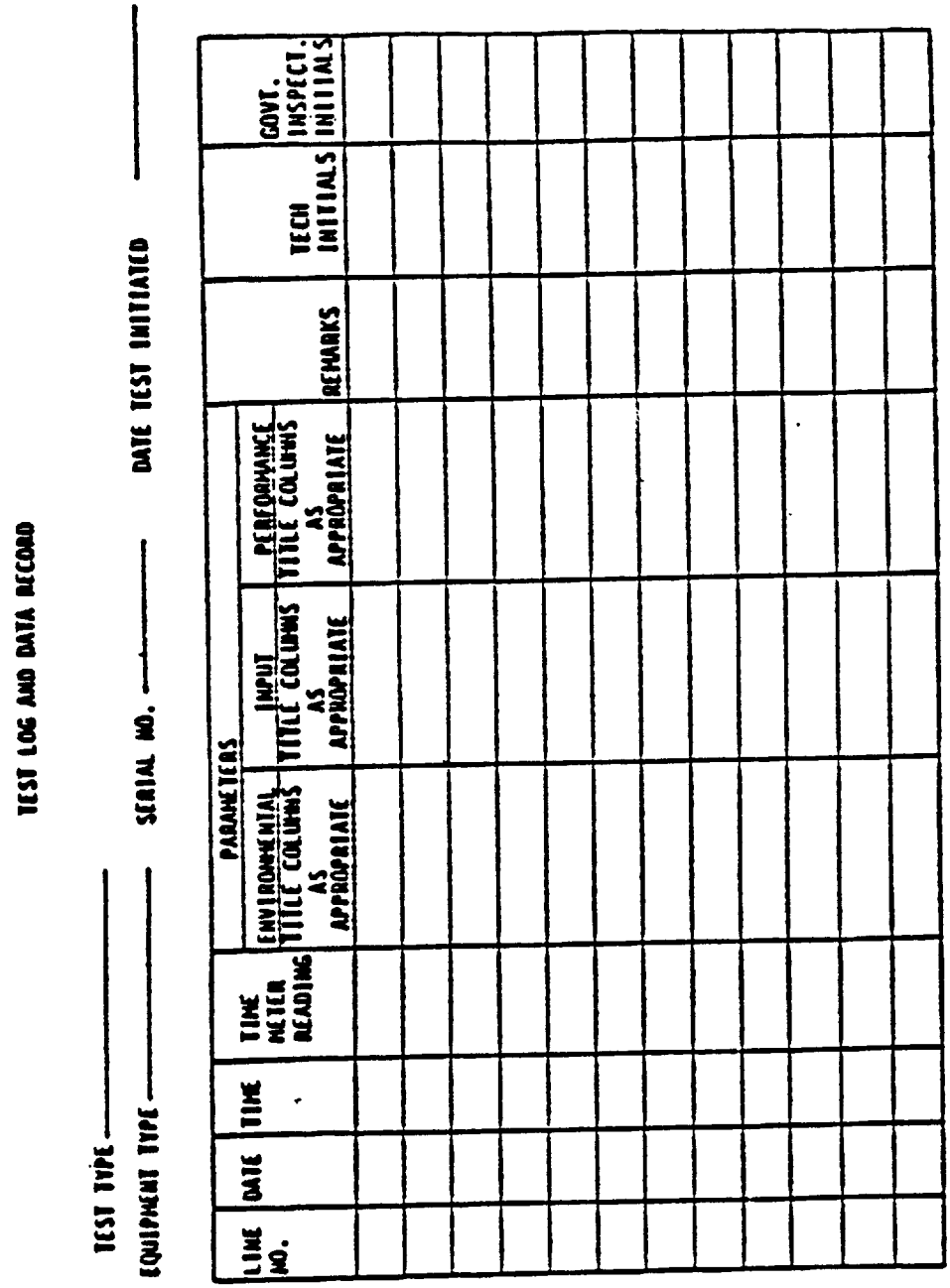


FIGURE 1. SAMPLE TEST LOG AND DATA RECORD

DI-R-7035 (Continued)

TYPE TEST _____ TEST POSITION _____

EQUIPMENT TYPE _____ DATE TEST INITIATED _____

UNIT SERIAL NO. _____

LINE NO.	FAILURE REPORT NO.	REMOVAL FOR REPAIR		RETURNED TO TEST		DESCRIPTION OF FAILURE	TECH INITIALS
		TIME/DATE	TIME METER READING	TIME/DATE	TIME METER READING		

FIGURE 2. SAMPLE EQUIPMENT FAILURE RECORD

DI-R-7035 (Continued)

FAILURE SUMMARY RECORD

TEST TYPE_____ DATE TEST INITIATED_____

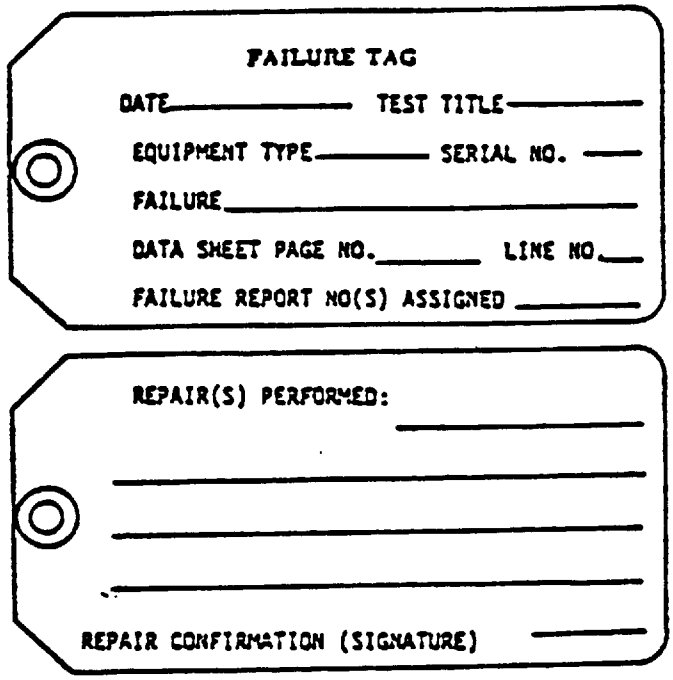
EQUIPMENT TYPE _____

DATE	FAILURE REPORT NO.	UNIT SERIAL NO.	UNIT TIME METER READING	DESCRIPTION OF FAILURE	TEST STATUS - ALL UNITS			TECH INITIALS
					CUMULATIVE FAILURES	CUMULATIVE TEST HOURS	MTBF	

FIGURE 3. SAMPLE FAILURE SUMMARY RECORD

DI-R-7035 (Continued)

FRONT



BACK

FIGURE 4. SAMPLE FAILURE TAG

FAILURE REPORT NO. _____
PART A

FAILURE IDENTIFICATION

SYSTEM _____ ASSEMBLY _____ SUBASSEMBLY _____ PART NO. _____

COMPONENT _____ SERIAL NO. _____ DATE _____ TIME _____

TOTAL UNIT TEST TIME _____ REPORT NO. _____

TEST TYPE _____ TEST REFERENCE _____

TEST AND ENVIRONMENTAL CONDITIONS: _____

IDENTIFICATION OF TEST EQUIP: _____

FAILURE SYMPTOMS: _____

ADJUSTMENT REQUIRED: _____

OTHER EQUIP. FAILURES OBSERVED SIMULTANEOUSLY WITH SUBJECT FAILURE: _____

TEST OPERATOR SIGNATURE _____

FIGURE 5. SAMPLE FAILURE REPORT (SHEET 1 OF 4)

DI-R-7035 (Continued)

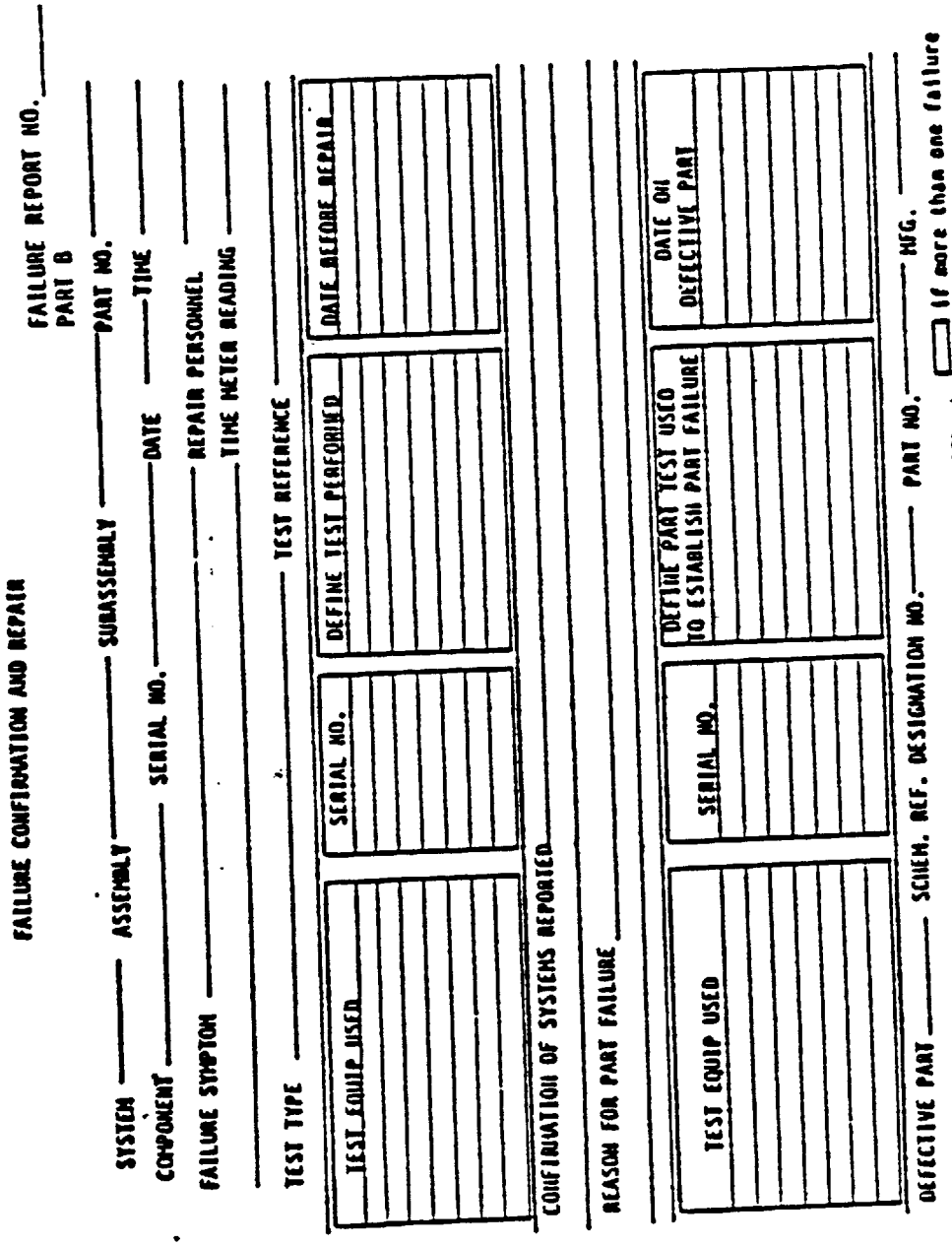


FIGURE 5. SAMPLE FAILURE REPORT (SHEET 2 OF 4)

DI-R-7035 (Continued)

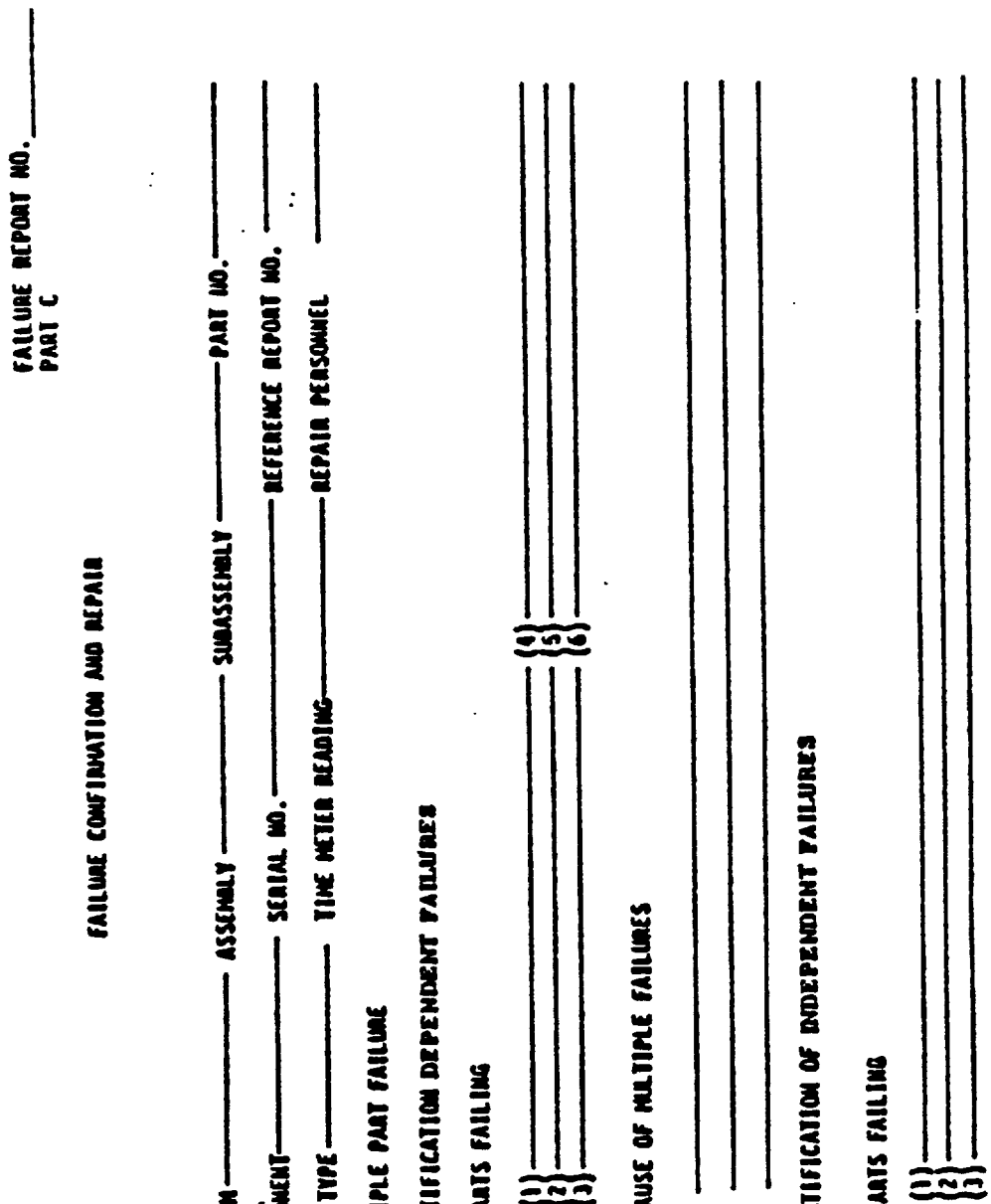


FIGURE 5. SAMPLE FAILURE REPORT (SHEET 3 OF 4)

DI-R-7035 (Continued)

FAILURE REPORT NO._____
PART D

FAILURE ANALYSIS AND CORRECTIVE ACTION

SYSTEM________ ASSEMBLY________ SUBASSEMBLY________ PART NO.________

COMPONENT________ SERIAL NO.________ DATE________ REPORT NO.________

TEST TYPE________ TEST REFERENCE________

COMPONENT ANALYSIS________

DESIGN ANALYSIS________

RECOMMENDATIONS FOR CORRECTIVE ACTION________

CORRECTIVE ACTION IMPLEMENTATION
EFFECTIVE DATE____ EQUIP. SER. NO.____ SIGNATURE________ TITLE________
REVIEW SIGNATURE________ RELIABILITY ENGINEER

FIGURE 5. SAMPLE FAILURE REPORT (SHEET 4 OF 4)

☆ U. S. GOVERNMENT PRINTING OFFICE: 1977-703-122/7030

APPENDIX IX

DATA ITEM DESCRIPTION	2. IDENTIFICATION NO(S). AGENCY	NUMBER
1. TITLE PLAN, MAINTAINABILITY PROGRAM	NAV-SHIPS	UDI-R-23558
3. DESCRIPTION/PURPOSE This document serves as basic documentation of the contractor's planning of the Maintainability Program to be conducted for the applicable contract items. The plan is used by the procuring activity for initial review and approval of the contractor's Maintainability Program and as the basis for monitoring and evaluating the contractor's conduct of the program.	4. APPROVAL DATE 72 APRIL 01	
	5. OFFICE OF PRIMARY RESPONSIBILITY SHIPS 0125	
	6. DDC REQUIRED	
	7. APPROVAL LIMITATION	
8. APPLICATION/INTERRELATIONSHIP This Data Item Description is applicable to contracts during contract definition and acquisition phases and equipment contracts when contractors are to conduct maintainability programs in accordance with MIL-STD-470. It may be combined with the Plan, Reliability Program, when considered appropriate by the procuring activity. The plan is obtained either precontractually (during the RFP/IFB phase) or as a product of the definition phase and updated during the acquisition phase, or prior to the production phase. NOTE: Consult Alphabetical Index for the DID number of the above cited title.	9. REFERENCES (Source Document or Standard) MIL-STD-470 MIL-STD-471 MIL-STD-721 MIL-M-24365	
	10. PREPARING ACTIVITY	

11. PREPARATION INSTRUCTIONS

1. The contractor shall prepare a written plan of his proposed Maintainability Program. The plan shall be either a detailed refinement and expansion of a Maintainability Program information provided in the original contract proposal, or a complete document when initially developed under the contract. It shall incorporate any changes to the original proposal growing out of contract negotiations and/or work accomplished during previous phases of the program.

a. When a prior Maintainability Program Plan has been proposed and approved by the procuring activity, or other activity of the Naval Material Command the specific requirements of this Data Item Description may be satisfied by supplementing the prior plan. The complete plan shall be submitted as directed.

b. Revisions shall incorporate changes, additions, or deletions which have evolved during conduct of the program since the previous issue of the plan.

c. If the total program life cycle of the contract item extends beyond the immediate contract period, the Program Plan shall provide the contractor's projected concept of the program which would be applicable in subsequent periods of the total life cycle. In these cases the plan shall clearly identify those actions which are to be conducted within the immediate contract period.

2. The Maintainability Program shall contain fully descriptive planning for the accomplishment of each Maintainability Program task specified by the contract

DD FORM 1664

PAGE 1 OF 3 PAGES

DATA SET CONTINUATION SHEET

TITLE: PLAN, MAINTAINABILITY PROGRAM

CONTROL NO.:

work statement and other applicable terms of the contract. The plan shall provide a cross-index, in accordance with the following outline, which shows the relationships between program tasks and (1) applicable specifications or standards cited by the contract work statement, (2) other reference documents, and (3) contractor policies and standards:

Format for Program Plan Cross-Index

Reference Paragraph of Applicable Maintainability Specification	Applicable Task or Paragraph No. of Program Plan	Other Reference Documents	Company Policies, Procedures & Controls	Estimated Manloading for 1st Month

3. The plan shall also identify and define:

a. The work to be accomplished for each applicable specification in block 9 as required by the Contract Work Statement or Contract Data Requirements List (DD Form 1423).

b. The time phasing and manloading involved.

c. The contractor organizational element assigned responsibility and authority for implementing the Maintainability Program.

d. Lines of communication between the contractor organizational element responsible for implementing the program and other contractor interfacing organizational elements.

e. Appropriate customer-contractor program milestone review points.

f. Method of control over subcontractor and vender Maintainability Programs.

g. The purpose and expected results of each task and the planned methods for monitoring, assessing, reporting, and taking appropriate action regarding the status, accomplishments, and problems.

h. Specific techniques for allocating quantitative requirements to lower level functional elements of the system (subsystem, assembly, or components).

i. Specific techniques for maintainability predictions.

j. Proposed methods for demonstrating the achievement of quantitative maintainability requirements.

4. The plan shall identify and define interfaces between the Maintainability Program and closely related programs or efforts such as:

a. Logistic support evaluations:

(1) Maintenance requirements analyses.

(2) Maintenance task analyses.

(3) Tool and test equipment determinations, to include calibration equipment and calibration requirements.

(4) Manpower, training, and skill requirements determination.

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DATA SET CONTINUATION SHEET

TITLE	CONTROL NO
PLAN, MAINTAINABILITY PROGRAM	UDI-R-23558

(5) Maintenance information systems; i.e., technical data, training manuals, etc.

(6) Support equipment/facilities determination.

b. Reliability Program.
c. Personnel Subsystem/Human Engineering/Safety Program.
d. Systems engineering.
e. Systems/cost effectiveness analysis.
f. System Life Cycle cost analysis.
g. Design engineering.
h. Value engineering.
i. Data collection and analysis procedures.
j. Quality control program

5. Specifications/Standards cited above are those in effect on the data of the RFP, RFQ, IFB, are applicable, unless otherwise specified by the contract.

APPENDIX X

DATA ITEM DESCRIPTION	IDENTIFICATION NO(S). AGENCY	NUMBER
1 TITLE PLAN, MAINTAINABILITY DEMONSTRATION	NAV-SHIPS	UDI-R-23564
2 DESCRIPTION/OBJECTIVE This document is used for review, approval and subsequent surveillance and evaluation of the contractor's program for conducting maintainability tests and demonstrations and assessing maintainability of the system, subsystem, equipment, and its constituent components based on results of these and other tests.	4 APPROVAL DATE 72 APRIL 01	
	5 OFFICE OF PRIMARY RESPONSIBILITY SHIPS 0125	
	6 DDC REQUIRED	
	8 APPROVAL LIMITATION	
7 APPLICATION/INTERRELATIONSHIP This Data Item Description is applicable for all contracts which require the demonstration of achievement of maintainability requirements. The following portions of this plan must be resolved during contract negotiations and form part of the contract: 2a(2), 2a(5), 2a(6), 2a(8), 2a(9), 2e(1), 2e(3), 2e(4), 2e(5), and 2e(6). This Data Item Description may be combined with the Reliability Test and Demonstration Plan, into a Reliability and Maintainability Demonstration Plan when considered appropriate by the procuring activity. NOTE: Consult the SADL Alphabetical Index for the corresponding DID number of the above cited title.	9 REFERENCE (Temporary or cite as Block 10) MIL-STD-470 MIL-STD-471 MIL-M-24365	
	10 SUPERSEDING DID(S)	

11 PREPARATION INSTRUCTIONS

1. The contractor shall prepare a plan in accordance with the applicable specification in Block 9 as required by the Contract Work Statement to demonstrate achievement of contractually specified maintainability requirements.

a. The initial plan shall be a detailed refinement and expansion of the maintainability demonstration section of the Maintainability Program Plan when applicable. Revisions or changes shall be submitted as required to update the plan.

b. The plan also shall identify all other tests and efforts from which maintainability evaluation data are expected as a by-product. For each such test, the plan shall contain the information cited, insofar as pertinent to maintainability evaluation.

2. The plan shall include the sections listed below as a minimum, or as specified on the DD Form 1423.

a. Demonstration Conditions. A description of:

(1) Types and estimated quantities of equipment used and data expected from the test.

(2) Methods and criteria of data recording and analysis, including criteria for classifying the results with respect to success, failure, and degree of relevancy to maintainability assessment.

(3) General plan of action to be taken with regard to test failures,

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DATA SET CONTINUATION SHEET

TITLE	CONTROL NO
PLAN, MAINTAINABILITY DEMONSTRATION	UDI-R-23504

(4) Method of reporting results of the tests, including format of the test report.

(5) Principal conditions of the test or demonstration such as personnel skill levels and equipment involved and their relation to corresponding conditions expected in ultimate use and maintenance of the contract items.

(6) Quantitative maintainability requirements.

(7) Maintenance concept.

(8) Maintenance demonstration environment.

(9) Levels of maintenance to be demonstrated.

(10) Demonstration sites.

(11) Facility requirements.

(12) Participating agencies.

(13) Mode of operation for the demonstration test, including configuration and mission requirements.

(14) Items to be demonstrated.

b. Demonstration Test Team. A description of:

(1) Organization.

(2) Degree of contractor and procuring activity participation, including:

(a) Managerial and technical personnel.

(b) Maintenance and operating personnel.

(3) Assignment of specific responsibilities.

(4) Qualifications, quantity, sources, training, and indoctrination requirements for the test team personnel.

c. Demonstration Support Material. A description of:

(1) Support equipment.

(2) Test facilities, tools, and test equipment, including calibration support requirements.

(3) Technical publications.

(4) Spares and consumables.

(5) Safety equipment.

d. Pre-demonstration Phase. A description of the schedule to provide for:

(1) Organization and assembly of the demonstration test team.

(2) Training of personnel.

(3) Preparation of facility and preliminary validation of demonstration support material.

(4) Availability, assembly, checkout, and preliminary validation of demonstration support material.

e. Formal Demonstration Phase. A description of:

(1) Test objectives.

(2) Schedule of tests.

(3) Task selection method.

(4) Test method.

(5) Data acquisition method.

(6) Analytical methods and calculation procedures.

(7) Specific data elements.

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DATA SET CONTINUATION SHEET

TITLE	CONTROL NO
PLAN, MAINTAINABILITY DEMONSTRATION	UDI-R-23564

(8) Time units of measurements.
(9) Type and schedule of reports.
(10) Description and schedule of preventive maintenance.

f. Retest Phase. A provisional schedule for special or repeat tests or demonstrations to investigate deficiencies or trouble areas. An equipment which has failed to meet the acceptance criteria and has been reworked shall be related during this phase.

3. Specifications/Standards cited above are those issues in effect on the date of the RFP, RFQ, or IFB, as applicable, unless otherwise specified by the contract.

APPENDIX XI
RELIABILITY AND MAINTAINABILITY SUPPORT CHARACTERISTICS

(NOTE: This appendix shall support and enhance MIL-STD-721C and MIL-STD-781C).

1.0 FAILURE DEFINITIONS

a. Failure. The inability of an item to perform within limits specified in the specification.

Whenever any of the performace characteristics are outside of requirements of the specification at any specified environmental condition, at least one failure has occurred.

b. Failure Analysis. The logical, systematic examination of an item or its reliability model to identify and analyze the probability, causes and consequences of potential failures.

c. Failure, Dependent. A failure of a part which is a direct result of an independent failure—one which is caused by the failure of an associated part. Dependent failure are not necessarily present when simultaneous failures occur.

d. Failure, independent. A failure which will independently cause equipment performance outside of specified limits—one which occurs without being related to the failure of associated items.

e. Failure Random. Any failure whose occurrence is specifically unpredictable but statistical predictable.

f. Failure Rate. The number of failures of an item per unit measure of life cycle, time, miles, events, etc., as applicable for the item.

g. Pattern Failure. The occurrence of two (2) or more failures of the same part in identical or equivalent application whose combined failure rate exceeds that predicted. When two (2) or more dependent failures of the same part occur whose combined failure rate exceeds the dependent failures are relevant pattern failures.

2.0 FAILURE DEFINITION.

The criteria specified herein for the determination of a failure shall be in addition and enhancement to the definition of failure as given in MIL-STD-721C, and any definition given in any applicable reliability test specification or standard.

2.1 FAILURE CLASSIFICATION

All failures occurring during reliability tests, including failures occurring during the equipment burn-in under the environmental conditions specified for the reliability tests, shall be classified and reported as either relevant or nonrelevant. Only those failures classified relevant shall be used in computing equipment MTBF or for making an accept/reject decision.

2.1.1 RELEVANT FAILURES

All failures are relevant unless otherwise determined by the Government. Relevant failures include:

a. Design/Workmanship Failures: Failures due to design deficiencies or poor workmanship of either the equipment or component parts shall be classified relevant.

b. Component Part Failures: Failures due to defective component parts shall be classified as relevant failures. In the event that several component parts of the same type fail during the tests, each shall beconsidered a separate relevant failure, unless it can be shown that one failure caused one or more of the others (see MIL-STD-781C, Dependent Failures in paragraph 1.a above).

c. Wearout Parts: Certain parts of known limited life, such as batteries, may have a life stipulated prior to the initiation of testing as approved by the Government. Failures of these parts occurring prior to the end of the stipulated period are relevant. Failures of these parts occuring after the stipulated period are nonrelevant, but any dependent failures caused thereby are relevant.

d. Multiple Failures: In the event simultaneous part failures occur, each failed part which would independently prevent satisfactory equipment performance shall be counted as a relevant failure except as follows: If the contractor and the Government agree that the failure of one part was entirely responsible for the failure of any other part, then each such dependent part failure shall not be counted for a relevant failure. At least one equipment relevant failure shall be counted when a dependent failure is claimed.

e. Intermittent Failures: The first occurrence of an intermittent failure on any one equipment shall be counted as a relevant failures. Subsequent occurrences of the same intermittency on the same unit will be considered nonrelevant. However, no parts shall be shipped for which an intermittent failure remains unresolved, without specified approval of the Government.

f. Adjustments:

1. Accessible Controls - Each adjustment of a control which is accessible to the operator during normal use is a relevant failure.

2. Inaccessible Controls - Each adjustment of a control which is inaccessible to the operator during normal use is a relevant failure unless a period of operating (not standby) time has elapsed, since the last adjustment of any inaccessible control on than equipment, which is equal to or greater than the period specified for the equipment "operational stability."

2.1.1 NONRELEVANT FAILURES

Although nonrelevant failures are not used for MTBF calculations, all failures shall be recorded and reported. These failures listed below may be counted as nonrelevant:

a. Failures directly attributable to improper installation in the test chamber.

b. Failures of test instrumentation or monitoring equipment.

c. Failures resulting from test operator error in setting up, or in testing the equipment.

d. Dependent failures, unless caused by degradation of items of known limited life,. (At least one relevant failure shall be counted when a dependent failure is claimed.)

e. Failures attributable to an error in the test procedures.

f. The second (and any subsequent) occurrences of the same intermittent failure on the same unit.

g. Failures occurring during burn-in, trouble-shooting, repair verification, or set-up time.

h. Malfunctions of the Time Totalizing Meters or certain lighting circuit failures, when the approved test procedures specifically designate them as nonrelevant.

i. Failures clearly attributable to an overstress condition caused by exposure to uncontrolled external forces in excess of the design requirements.

j. Adjustments:

1. Accessible Controls - Adjustments of controls which are accessible to the operator during normal use shall be counted as nonrelevant failures provided the adjustament is accomplished without reference to test equipment, meters, indicators, etc., which are not a functional part of the equipment under test.

2. Inaccessible Controls - Control which are not accessible to the operator during noraml use are nonrelevant failures provided no such adjustments have been made to the unit under test for a period of operating time at least equal to that specified for the subsystem "operational stability."

k. Other, as explicitly defined in the approved test procedures.

2.1.3 RECLASSIFICATION

A failure, classified as relevant, may be reclassified to nonrelevant provided that all of the following conditions are met:

a. Corrective action (an equipment design, part or production process changed) has been made in accordance with the applicable reliability test specification or standard on all equipment of the lot from which the reliability test sample was drawn, and;

b. Sufficient test data has been accumulated to indicate the corrective action is effective in eliminating the failure mode, and;

c. Approval of the Government is obtained for reclassification of the failure.

APPENDIX XII

DATA ITEM DESCRIPTION	2 IDENTIFICATION NO(S)	
	AGENCY	NUMBER
1 TITLE Implementation Test Procedures (Electronic Systems)	USAF	DI-T-3737
3 DESCRIPTION/PURPOSE This Data Item Description provides the procedures to be used in the testing of successive operating sites of multisite systems to ensure that these sites, individually and severally, function as parts of a system in accordance with the requirements of the system performance specification.	4 APPROVAL DATE 18 May 1977	
	5 OFFICE OF PRIMARY RESPONSIBILITY AFSC/TE	
	6 DDC REQUIRED	
	8 APPROVAL LIMITATION	
7 APPLICATION/INTERRELATIONSHIP Pertains to real-time functional tests performed at a system level, subsequently to site installation and checkout. Sites pertaining are ground installations, airborne vehicles, space platforms, or tactical emplacements, wherever they collectively comprise a system.	9 REFERENCES (Applicable to this data item) TO 31-1-8 AFR 80-14	
	MGSL NUMBER(S)	

10. PREPARATION INSTRUCTIONS

a. General:

(1) A digest description of the overall system, its mission, functions, and if applicable, a large-scale map indicating site locations, interconnecting links, and a general block diagram of all major elements of the system.

(2) Description of recognizable subsystems, including accepted titles and/or code names for these subsystems. The subsystems should include all the equipment and computer program portions of the system identified as unique in operation or time phasing.

(3) Security guidelines abstracted from applicable documents.

b. Scope of Testing:

(1) Describe the specific test configuration at each site and the nature and extent of testing anticipated. Include requirements for testing computer programs applicable to the mission/configuration of each site.

(2) List related tests, and pretest requirements or conditions, including a list of all subsystem test and sequence of testing.

(3) List any special tests, such as for computer program site adaptation, interference, etc., that may be required for each site.

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DI-T-3737 (Continued
Preparation Instructions (Continued)

c. Objectives of Testing:

(1) Identify specific test objectives in terms of measurable or attainable functions, parameters, and performance requirements. (Information required in this section may be published as appendixes or additional volumes).

(2) Describe any operational conditions or limitations which may restrict attaining any of the previous objectives included in the preceding paragraph.

(3) Describe the general operational conditions of the equipment group(s) and computer program status necessary to attain each objective.

d. Procedures:

(1) Outline the basic test methods which will be used to achieve the specified test objectives and indicate responsibility for test direction, operation, and observation.

(2) Specify the operational status of interconnecting systems/subsystems which are required before each of the tests can begin. For tests involving computer programs, include identification of simulation and/or data generation vehicles to be used.

(3) For measures of performance.

(a) Identify and describe all performance measures (instruments) which are required to satisfy the objectives. Include measuring techniques and the number of measurements to be made, and explain how uncontrolled parameters or operator effects can be treated.

(b) List the acceptable limits (figures of merit) for each instrument specified.

e. Support Requirements. Indicate detailed test support requirements, including aircraft, operators, observers, data reduction/analysis programs, simulation inputs, data recording devices, test equipment list, and instrumentation plan layout.

f. Documentation of Test Procedures. Specify requirements and procedures for preparing, reviewing, and, if necessary, revising documentation of specific test procedures.

g. Interface with Technical Approval Demonstration (TAD). Outline the relationship between the implementation test program and the demonstration requirements of the TAD. Identify all tests to be conducted for the TAD team and indicate who will perform these.

DI-T-3737 (Continued)
Preparation Instructions (Continued)

h. Method. The contractor shall prepare a document which will contain implementation test methods that provide step-by-step instructions which will allow an engineer or technician who is familiar with the equipment and/or system/subsystem involved to perform each test without recourse to any other document. It should include:

(1) A description and purpose of each test, referencing the applicable Implementation Test Plan objective.

(2) Test team or other personnel requirements, their positions, and duties.

(3) A list of minimum support equipment and services required to perform the test.

(4) A listing of supporting tests which must be completed prior to starting the specific tests at hand.

(5) References to documents, technical orders, and operating and maintenance handbooks with which the test personnel should be familiar before undertaking the tests.

(6) Ancillary requirements, such as communications, data links, and temporary electrical and electronic services.

(7) A list of test equipment which will be required by amount, stock number, nomenclature, and description. Indicate the test equipment which is normally furnished with or built into the equipment. (Test equipment may include computer programs and data collection programs.)

(8) Recording requirements, procedures, and samples of the standard and special reporting forms to be used.

(9) Pretest actions within a system/subsystem and between subsystems; e.g., communication checks between the test director and observers, checking the mode of data flow, etc.

(10) A sequential step-by-step set of instructions and criteria with appropriate block diagrams for each test specified in the Implementation Test Plan. Appropriate instructions should be given for any alternatives. When appropriate, include "Caution notes" and "Results Required" before proceeding with the next text. A complete listing of each instrument, with its associated tolerance limits for each objective identified in the test plan, will also be included.

(11) Actions to be taken at the end of testing which will insure that the equipment or system/subsystem is left in its normal operating condition.

★U.S. GOVERNMENT PRINTING OFFICE: 1977-700-122/6880

APPENDIX XIII

DATA ITEM DESCRIPTION	IDENTIFICATION NUMBER: AGENCY	NUMBER
1. TITLE: PROCEDURES, TEST	NAVY-SE	UDI-T-23732B

2. DESCRIPTION/PURPOSE

This data item is used to describe a contractor's test procedure and how he intends to determine compliance with specification requirements.

4. APPROVAL DATE: 74 Oct 23

5. OFFICE OF PRIMARY RESPONSIBILITY: SEA 9833

6. DDC REQUIRED:

8. APPROVAL LIMITATION:

7. APPLICATION/INTERRELATIONSHIP

Application will be as specified by the contract data requirements list. This item may be used whenever tests are required.

9. REFERENCES (Cumulative; list in order used):

10. PREPARATION INSTRUCTIONS

10.1 The test procedures shall be typed in contractor or commercial format on 8"x10½" sheets.

10.2 The test procedures shall cover in detail the plan and procedures for accomplishment of the tests specified in the contract schedule and specifications referenced therein or in Block 16 of the DD Form 1423, Contract Data Requirements List, data item requiring these procedures and shall specifically cover or contain the following as applicable:

a. Title
b. Index
c. Identification of item being tested (serial number)
d. Identification number of test procedure
e. Hardware configuration
f. Test prerequisites
g. Report form
h. Date, time and duration of test
i. Proposed test(s)
j. Preoperational checklist
k. The purpose of the test(s)

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PROCEDURES, TEST (Continued)

l. Description of test
m. The specification paragraph(s) to which the test(s) will prove compliance.
n. Detailed step-by-step procedure (may be referenced to test number and test title in Government documents)
o. Test schedule (operating profile, setpoints, stabilization time, data points)
p. The test equipment utilized.
q. Approvals, authorities and responsibilities
r. Sketches or photographs of test set-up
s. Facilities required for test
t. Test equipment requirements (major and special)
u. Methods of measurement(s)
v. Logistics equipment requirements (spare test hardware)
w. Method of control of sub-contractor's efforts and their procedures.
x. Applied instrumentation and data recording equipment
y. Data sheets (when required by a specification) for which the results are able to be correlated to the item tested.
z. Types of data to be recorded (parameters, ranges, accuracies, type readout, and quantities)
aa. Results (comparison of test data to acceptance standard)
bb. Accept/reject criteria for test acceptance.
cc. Personnel required
dd. Special resource requirements
ee. References to specs, standards, tech manuals, other test procedures and reports, change orders, notices, and other references not specific to the test but included for information only.

In addition to the requirements of paragraph 10.2, the production test edures shall cover cleaning/refurbishing of test equipment and, if applicable, rrelationship for and during availability test(s).

APPENDIX XIV

DATA ITEM DESCRIPTION	IDENTIFICATION NO(S)	
	AGENCY	NUMBER
TITLE: REPORT, ACCEPTANCE TEST	NAVY-EC	UDI-T-22741A
DESCRIPTION/PURPOSE: This report provides verification data that the equipment, system, subsystem, or assembly has passed all the required acceptance tests which demonstrate and verify that the equipment, system, subsystem or assembly has met or exceeded the performance specification.	APPROVAL DATE: 1 JUL 76	
	OFFICE OF PRIMARY RESPONSIBILITY: NAVELEX 52024A	
	DOC REFERENCE:	
	COMMENTS:	
APPLICATION/INTERFACE: This report is applicable to all contracts where a contractor delivers and installs equipment, systems, subsystems or assemblies and is used to record final acceptance test results as accepted by the government.	REFERENCES (Source document or standard):	
	NEXT HIGHER ASSY:	

PREPARATION INSTRUCTIONS:

10.1 The Contractor shall prepare report/reports showing completion and results of tests performed to demonstrate that the equipment, system, subsystem or assembly performs its design function as required by the specification, exhibit/statement of work applicable to the equipment, system, subsystem, or assembly. The report shall be prepared in the Contractor's format.

10.2 The Contractor's report shall be typewritten on approximately 8 X 10 1/2" white paper, securely stapled on the left margin. The Report shall include, but is not limited to, the following:

a. Contractor's name and address
b. Contract number
c. Date of report
d. Title
e. Serial number of report
f. Period covered by test report
g. Description of problem areas encountered, discrepancies and recommendations, if any, for subsequent solution thereto.
h. Results obtained related to previously identified problem areas.
i. Summary of Engineering Change Proposals (ECP) status, including identification of those proposed, those approved, and those implemented.
j. Name of person(s) preparing report, including telephone number.
k. Specific identification of equipment, system, subsystem or assemblies covered by this report.

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APPENDIX XV

SERPENT CONNECTOR CHARACTERISTICS

FAA EXTERNAL CABLE CONNECTIONS

This section describes the IBM serpent connector and its assembly to coaxial or twisted pair cables. Any changes to the connector assemblies will be brought immediately to the attention of the FAA. All dimensions shown in the accompanying figures are nominal values for reference purposes only.

General Description

External cables will consist of coaxial or twisted pair cables, terminated at the ends engaging IBM equipment with "serpent connectors." (The serpent connector is an IBM design which serves to interface IBM equipment.) The cable ends engaging the attached devices will be terminated by connectors specified by the using agency.

Manufacturing Facilities for Cable Assemblies

Listed below are cable manufacturers presently known to have equipment an experience in assembling the serpent connector. These manufacturers also are experienced in working with the other general types of connectors.

Robinson Technical Products
3421 Old Vestal Road
Vestal, New York

Amphenol Cadre Division
20 Valley Street
Endwell, New York

Ran Electronics
755 New Ludlow Road
South Hadley Falls, Mass.

Serpent Connector

There are variations of the serpent connector. The connector to be used in a specific application is governed by the mating connector on the IBM equipment end of the cables. Connector kits may be furnished to the device contractors as GFE.

Serpent connectors are available in two types: Type A: and type B. The A and B types are complements to each other -- somewhat analogous to plugs and sockets in commonly used connector assemblies. In the case of the serpent connector system, it would be physically possible to couple two connectors of the same type:

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however, in this event, corresponding contact positions would not engage. (For example, position B2 would engage position D-2 etc.) The Type B block, therefore, has contact identifications which are a mirror image of identifications on the Type A block. To facilitate identification, the Type A block is light grey in color, and the Type B block is dark grey.

Twenty-four or forty-eight individual pin positions (serpent contact) are provided for in the connector blocks. Application of the connector is limited only by the number of coaxial or twisted pair wires used and the method required to terminate the shields.

Figures B-1 through B-7 apply to both Type A and Type B 24 position connector assemblies.

Figure B-8 through B-10 apply to Type B 48 position connector assemblies.

Serpent Connector Assembly

The following items provide information regarding assembly and handling of the serpent connector system.

Crimped terminations are used on the contacts. Crimping tools compatible with the contact design, must be used to insure a reliable termination, and to avoid damage to functional portions of the contact. (Soldered terminations are not recommended for this contact.) Proper crimping facilities for the IBM serpent contact system are available from the IBM Corporation.

Contacts for the wire ranges can be distinguished by examining the "U" shaped section which accepts the conductor. This section on the #24-#26 contact has a height of .070"; on the #26-#29 contact, the height is .042".

If requirements for spare contacts arise, they are available from IBM under Part Nos. 5362301, 5362302, and 5404480. These contacts cover the range of solid or stranded wire sizes listed in Table B-1. Wire combinations can be terminated as indicated.

Contacts may be removed from the connector block by use of a smooth instrument, suitable for depressing the retaining lug. (Scratches on functional surfaces of the contact must be avoided.) A readily available instrument, suitable for occasional usage, is the #12 "Boye" crocheting needle.

Contact removal, or mishandling of the contact, can cause deformation of the retaining lug. The .025" plus .015" minus .000" reference dimension shown in Figure B-4 must be maintained to insure contact retention. The lug may be reformed to comply with this dimension. It is especially important that the position of the retaining lug be checked in cases where a contact is removed and then reinstalled in the connector block.

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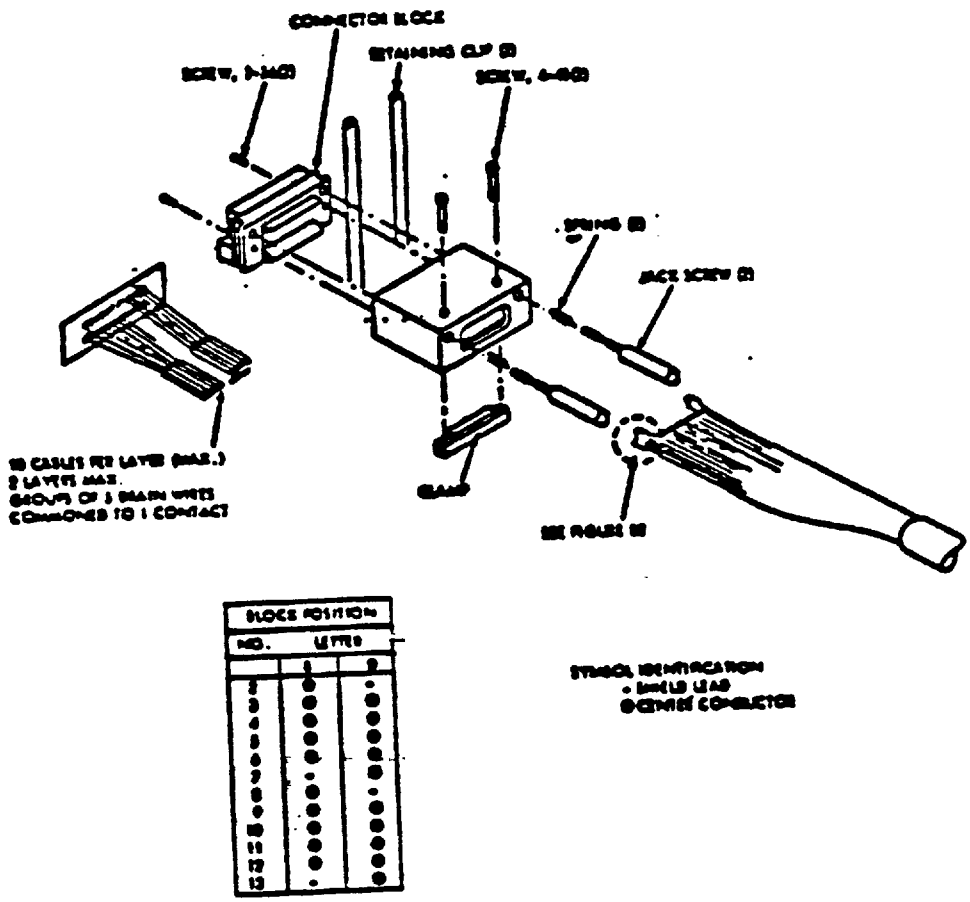

Figure B-1. 24 Position (Type A or B) Connector Assembly for Coax Cable

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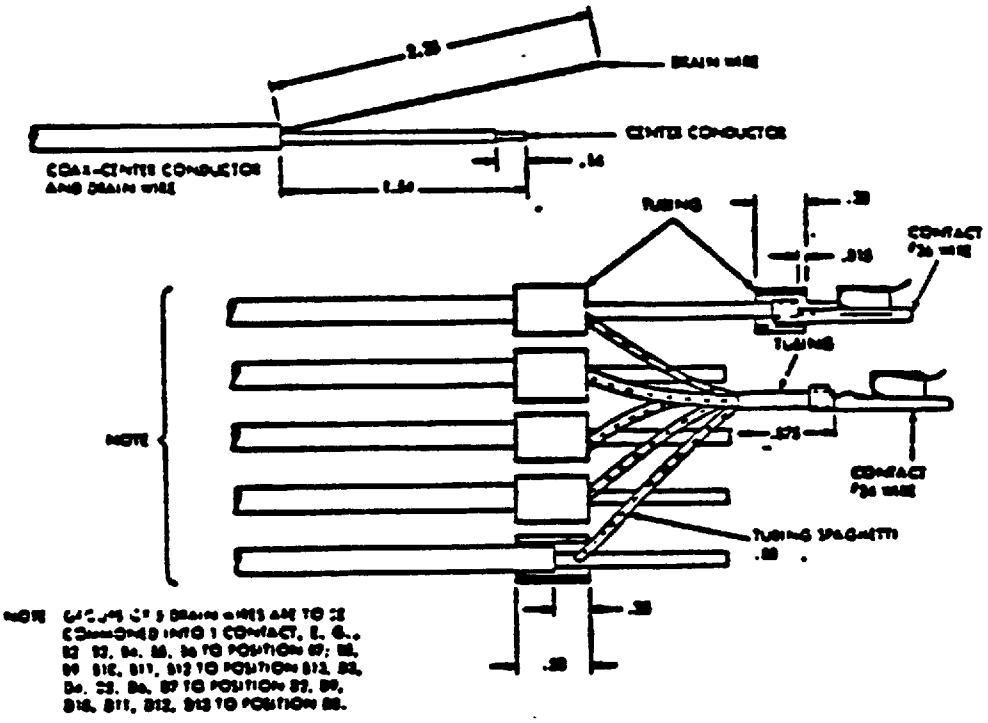

Figure B-2. 24 Position Connector (Coax Cable) Terminations

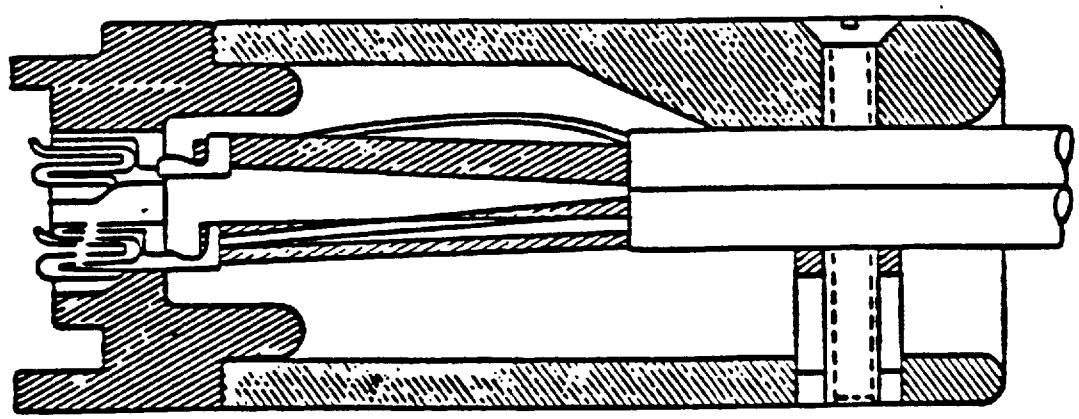

Figure B-3. 24 Position Connector Orientation

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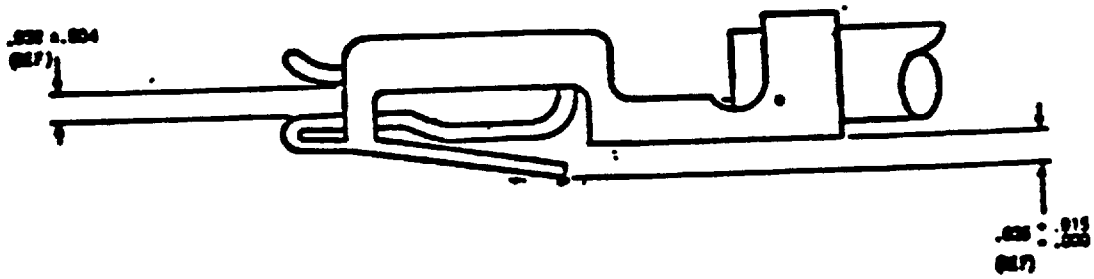

Figure B-4. Serpent Contact Tolerances

NOTE: Figures B-5 through B-10 are missing. Method of terminating cables are not defined at this time.

Table B-1. Wire Terminations

Terminating Individual Wires	Contact	Terminating Multiple Wires	Contact
#22 Solid & Stranded	5362301	Two #24 Solid	5404480
#24 Solid & Stranded	5362301	Two #24 Stranded	5404480
#26 Solid & Stranded	5362301	Two #26 Solid	5362301
#29 Solid	5362302	Two #29 Solid	5362302
#30 Solid	5362302	Two #30 Solid	5362302
#18 Solid & Stranded	5404480	Five #29 Solid	5362301
#20 Solid & Stranded	5404480	Ten #29 Solid	5404480
#32 Solid	5362302	Two #22 Solid	5404480
		Two #22 Stranded	5404480
		20 & 24 Solid	5404480
		20 & 24 Stranded	5404480

Mishandling of the contact can also cause a change in the contact gap. The .028" plus or minus .004" reference dimension in Figure B-4 represents the correct spacing.

The tubing, noted in Figure B-2 is dilated by soaking in toluene before installation.

To guard against damage to contacts during shipment and installation of cables, connectors should be provided with suitable protection.

Improper handling during assembly of the coax cable connectors can result in breakage of drain wire leads. A satisfactory repair for such breakage can be effected by terminating the shield with an insulated shield terminator (example: AMP Part No. 328839) and a lead of #26 insulated wire. The serpent contact would in turn by terminated to this lead.

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APPENDIX XV

24 Position Type A/B Coax Cable Connector Kits

A kit for the 24-position connector, type A or B, containing the items required to terminate one end of a 20-coax cable is available under the following identification:

PN 5393087 Connector Kit, 24-Position, Type A
PN 5402250 Connector Kit, 24-Position, Type B

The contents of the 24-position Type A connector kit (Part #5393087) are as follows:

Quantity	Description
20	Contact, #26 Wire Size
4	Contact, #24 Wire Size
1	Cover, Connector
1	Block, Connector Housing Type A (Light Grey)
2	Screw, Jack
1	Clamp, Cable
2	Spring, Compressing
2	Screw, Flat Head, 4-40 x 1 inch
2	Clip, Retaining
2	Screw, Flat Head, 2-56 x .5"
9 Inches	Tubing
11 Inches	Tubing
19 Inches	Tubing, Insulating
4 Inches	Tubing

A kit for the 24 position connector Type B is available under the following identification:

Part #5402250 - Connector Kit, 24-position, Type B

The contents of the kit are identical to those for the 24-position Type A connector, except the connector block is dark grey in color and the pin identification is reversed as previously described.

PAM Connectors

The connectors used for the cables plugging into the PAM are 24-position connectors: Type A and Type B. Type A is used on the input to the PAM's. Type B is used on the ouput of one PAM which connects to the input of another PAM.

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CONFIGURATION CONSOLE CONNECTORS

The connectors used for cables plugging into the Configuration Console are 24-position connectors. The Type-B connector is used on the Configuration Console end of the cable.

DATA ADAPTER UNIT CONNECTORS

The connectors used for cables plugging into the Data Adapter Unit are 48-position connectors. The Type B connector is used on the Data Adapter end of the cable.

DISPLAY ELEMENT CONNECTORS

The connectors used for cables plugging into the Display Element are 48-position connectors. The Type B connector is used on the Display Element end of the cable.

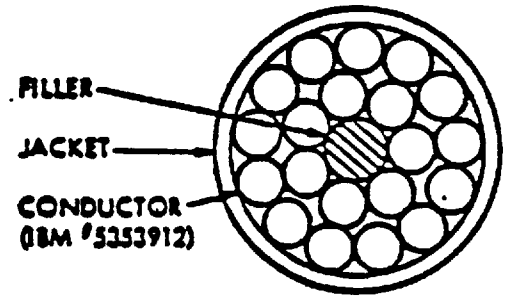
CHARACTERISTICS OF COAX CABLE

The characteristics of bulk coax cable (IBM #5353913) and the coax wire used therin (IBM #5353912) are described in Figures B-11 through B-12.

The flat cable impedance matches that of the coax cable. Connectors represent insignificant DC resistance. Impedance mismatch resulting form connectors is compensated for when establishing circuit noise parameters.

BULK CABLE, 20 LINE, COAXIAL

The bulk cable (IBM Part Number 5353913) contains 20 coaxial lines encased in a plastic jacket. Each coaxial line incorporates a "drain wire" in contact with the shiel to facilitate termination to the serpent connector system. Detail characteristics of the cable are listed elsewhere in this Appendix.



CONDUCTOR - 20 EACH WIRE-COAX (IBM #5353912)

FILLER - PVC

WRAPPER - MYLAR (.001 INCH)

JACKET - PVC (.085 INCH MINIMUM WALL THICKNESS)

TENSILE STRENGTH - 1800 PSI MINIMUM

ELONGATION - 200% MINIMUM

HARDNESS - SHORE A 85 ±5

FINISH - SMOOTH

CABLE O.D. - .978 ±.04 INCH

Figure B-11. Cable, Coax-20 Conductor (IBM #5353913)

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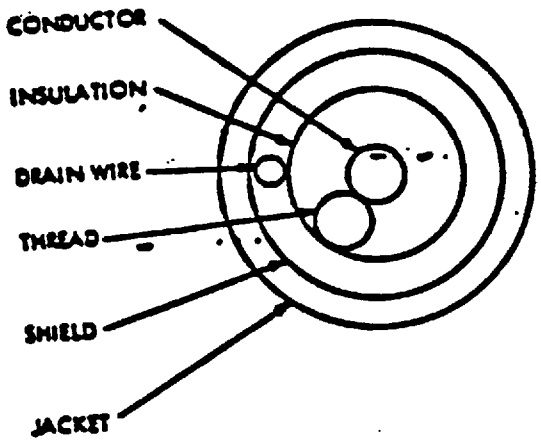

CONDUCTOR	- #26 AWG SOLID COPPER, SILVER PLATED
THREAD	- RULAN (.025 INCH) 0.50-INCH LAY
INSULATION	- RULAN (.018 INCH MINIMUM)
DRAIN WIRE	- #29 AWG SOLID COPPER, SILVER PLATED, SPIRAL WRAP, 0.50-INCH LAY
SHIELD	- 7 ENDS #38 AWG TINNED COPPER, 16 CARRIERS, 14 PICKS PER INCH
JACKET	- PVC (.015 MINIMUM WALL THICKNESS)
OUTSIDE DIAMETER	- .155 ±.005 INCH MEASURED OVER DRAIN WIRE
ELECTRICAL CHARACTERISTICS - CAPACITANCE	- 13.5 PF PER FOOT
CHARACTERISTIC IMPEDANCE	- 95 ±3 OHMS
ATTENUATION	- 10 DB PER 100 FEET @ 400 MC
VELOCITY OF PROPAGATION	- 82%
DC RESISTANCE	- 52 OHMS (MAX.) PER 1000 FT (CONDUCTOR)
	100 OHMS (MAX.) PER 1000 FT (DRAIN WIRE)

NOTE: FINISHED WIRE MUST WITHSTAND 10 TURNS AROUND A 1.00-INCH MANDREL. THEN RE-WRAPPED 10 TURNS IN THE OPPOSITE DIRECTION. WRAPPING MUST NOT DAMAGE DRAIN WIRE OR CAUSE VISUAL PROTRUSION THRU OUTER JACKET.

Figure B-12. Wire, Coax (IBM #5353912)

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GENERAL PURPOSE INPUT ADAPTER

General Characteristics

This adapter will present a device interface to enable various devices to send and control data transferred to the processor. Normally the GPI adapter will accept data in a format of 8 bits plus parity in parallel. The maximum data rate is determined by the 9020 System. However, any number of bits may be used, to a maximum of 8, either with or without parity. The parity may be either odd or even. In all cases, the device will initiate the data transfer signal and will work with the GPI adapter on a demand/response basis. Unused data positions will be presented to the processor as zeros.

General Description

Interfaces

The GPI adapter provides for communication between the input device and PAM common. The GPI communicates with PAM common over the adapter interface and with the input device over a device interface.

Device Interface. The device interface lines between the GPI adapter and the device are listed below and described later. There are 15 lines:

8 Data In Lines
1 Parity In Line
1 I/O Request In Line
1 Adapter Response Out Line
1 EOM In Line
3 Device Control Out Lines

Commands

The GPI adapter will decode commands from the channel and indicate the acceptance or rejection of the command to the channel during a select cycle. The valid commands for the GPI adapter are as follows:

Command	Code							
	0	1	2	3	4	5	6	7
Test I/O	0	0	0	0	0	0	0	0
Control No-Op	0	0	0	0	0	0	1	1
Sense	0	0	0	0	0	1	0	0
Read	1	M	0	M	M	0	1	0
Test Read Mode	M	M	1	M	M	0	1	0

M = Modifier bit may be 0 or 1, but bits 1, 3 & 4 can not all be zero.

Any other codes with correct parity will set sense bit 0, Command Reject and present the Unit Check bit in the status byte in response to the command.

Test I/O (0000 0000). If the Test I/O command is accepted by the GPI adapter and no outstanding status conditions exist, a zero status byte is returned to the channel. If status information is pending, all status bits present are transmitted to the channel.

Control No-Op (0000 0011). The control no-op command is treated as an immediate type command. It performs no operation, and Channel End and Device End are transmitted together during the initial selection cycle.

Sense (0000 0100). When the GPI adapter has accepted a sense command, it will initiate a service request to the channel through PAM common. When the adapter is serviced, it will gate the contents of its sense register with correct parity to the channel. When the sense byte is accepted, the GPI will initiate a termination sequence.

Read (1M0M M010). Internally to the GPI adapter these commands work the same; the only difference being in the output signal presented by the three Device Control Lines to the device due to the setting of the three modifier bits. Device Control Lines 1, 3 and 4 are set by modifier bits 1, 3 and 4 respectively.

The modifier bit zero of this command code is set to a "one" to condition a second gate for each output signal from the adapter to the device. The purpose is to prevent erroneous signals from being transmitted to the device in the event of a component failure.

When the GPI has accepted a read command, it will allow the device to initiate a data transfer signal (I/O Request In). When the GPI has received this signal, it will sample the input data lines and send a response signal back to the device (Adapter Response Out). The GPI adapter will also ask for service in via the PAM common. When the GPI is granted service, it will place the contents of its data register with proper parity on data Bus In. After this data has been accepted by the channel, the GPI adapter will again allow the device to initiate a new I/O Request In. This sequence is repeated until termination is indicated. Termination can be indicated in one of two ways:

A. Device determines End

After the last byte of a message has been sent to the channel, the device will present a termination signal (EOM In). At I/O Request In time, the GPI adapter will initiate a termination sequence.

B. Channel determines End

When the byte count equals zero and the channel receives a Request In from the GPI adapter, the channel stops data transfer and signals the adapter. The adapter will then initiate a termination sequence.

Test Read Mode (MM1M M010). Once the GPI adapter has accepted any of the Test Read Mode commands, it will degate the device interface and allow the adapter to monitor and initiate a signal on the test lines to and from the Test and Monitor adapter.

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Status Information

The status byte is transmitted to the channel in the following situations:

1. During initial selection.
2. At termination of any adapter command.
3. When permitted to present queued status.

Status Byte Format

Bit	Designation
P	Parity
0	Not Used
1	Not Used
2	Not Used
3	Not Used
4	Channel End
5	Device End
6	Unit Check
7	Not Used

Status Bit 4 and 5 - Channel End and Device End. Channel End and Device End status are always presented together by the GPI adapter. Once set, the I/O operation will be terminated and the adapter will present status to the channel when allowed to do so.

These bits are set on the following conditions:

1. During the initial selection phase of a Control No-Op.
2. At the termination of a Sense command.
3. At the termination of a Read or Test Read Mode command.
4. Upon detection of a Halt I/O condition.

The Channel and Device End conditions are reset by the acceptance of a status byte by the channel.

Status Bit 6 - Unit Check. Unit Check status is indicated only during an initial selection of at Channel End and Device End time of a Read command. To enable the processor to obtain a more detailed picture of the cause of the Unit Check condition, a sense command should be initiated. Unit Check is set when the following conditions are detected:

a. During an initial selection - cycle
   1. Command Reject
   2. Bus Out Check
b. At Channel End and Device End time of a read command.
   1. Data Check

The Unit Check condition is reset by acceptance of a status byte by the channel.

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Sense Information

A sense command should be initiated upon detection of a Unit Check condition in the status byte. The sense register positions are reset by the acceptance of the next valid Read or Test Mode command. With the exception of bit 2, Bus Out Check, the sense register is also reset when Bus Out Check occurs during Command Out. With the exception of the Command Reject bit, the sense register is also reset when a Command Reject occurs.

Sense Byte Format

Bit	Designation
P	Parity
0	Command Reject
1	Not Used
2	Bus Out Check
3	Not Used
4	Data Check
5	Not Used
6	Not Used
7	Not Used

Sense Bit 0 - Command Reject. Command Reject will be set during the initial selection cycle of a command if the code with correct parity is other than those listed in the "Commands" selection of the GPI description (above). All other sense register positions are reset.

Sense Bit 2 - Bus Out Check. Bus Out Check will be set at anytime a Bus Out Check signal is received over the adapter interface. A Bus Out Check signal will occur if PAM common detects a parity error on the Data Bus Out (from the IOCE to PAM common) and the Command Out tag is active.

A Bus Out Check detected during a select sequence will set a Unit Check bit in the status byte, the command will be ignored, and the operation is not initiated. The sense register, with the exception of Bus Out Checks, will be reset at this time.

Sense Bit 4 - Data Check. Data Check will be set only during a read operation when the GPI adapter detects a data byte with incorrect parity. The parity will be corrected by the GPI adapter as the byte is transmitted to the channel. Data Check itself will not terminate the read operation but will set a Unit Check condition during the read termination sequence.

Priority

The priority position is address dependent, i.e., the lower address assigned the higher the priority. To upgrade or downgrade the priority of a particular adapter, the address of the adapter must be changed accordingly. The reassignment of the priority (and address) is changeable in the field.

General Purpose Device Input Interface Description

General Introduction

The General Purpose Input interface provides a uniform method of attaching input devices to a general - purpose input adapter. It consists of a set of lines which are used to transmit information from the input device. Each interface can accomodate one input device.

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The signal lines for the General Purpose Input interface are as follows:

Signal Lines for the GPI Interface

Data Lines	Initiated By
Data In Bit Pos. P	Device
Data In Bit Pos. 0	Device
Data In Bit Pos. 1	Device
Data In Bit Pos. 2	Device
Data In Bit Pos. 3	Device
Data In Bit Pos. 4	Device
Data In Bit Pos. 5	Device
Data In Bit Pos. 6	Device
Data In Bit Pos. 7	Device

Control Lines	Initiated By
I/O Request In	Device
Adapter Response Out	Adapter
Device Control Line 1 Out	Adapter
Device Control Line 3 Out	Adapter
Device Control Line 4 Out	Adapter
EOM In	Device

Signal Lines Description

Data In Lines (Bits 0-7). The signal levels on these eight parallel lines will be presented to the adapter by the device and be static when the I/O Request is detected by the adapter. The adapter is capable of monitoring up to 8 data lines; however, the device need only present the number of data signals applicable to the device. If less than 8 data lines are used, then the high order positions starting with bit 0 are not used.

Parity Line. The signal level on this line is originated by the device to establish even or odd parity for the associated data lines. System parity is odd and is preferable at the device. The signal will be presented to the adapter and will be static when the I/O Request is detected by the adapter. The device need only present this line if applicable. Odd or even assignment is jumper wired and is changeable in the field.

I/O Request In. The signal level on this line is initiated by the input device. When an active I/O Request signal is detected by the adapter at a time that the adapter is selected and the adapter data register is empty, the adapter will sample the status of the data and parity lines into the adapter data register. The I/O Request signal will also be used to sample the EOM line.

By controlling the frequency of the I/O Request line, the device sets the data transfer rate within system limitation. The device will only make the I/O Request signal inactive when the adapter response signal is detected by the device. The I/O Request signal must be made inactive and then active again before the transmission of either another data character or the EOM signal is possible.

Adapter Response Out. An active signal on this line is initiated by the adapter and indicates to the device that the adapter has sampled the data, parity, and EOM lines. The adapter response signal will go inactive when the device causes the I/O Request signal to go inactive. The active to inactive transition of the Adapter Response signal could

occur before the associated I/O Request signal went inactive if the channel recognized the termination sequence before the device dropped the I/O Request signal.

Device Control Line 1 Out - Device Control Line 3 Out - Device Control Line 4 Out. The signals of these three lines will be initiated by the adapter when selected to perform a read operation. These signals will remain active until termination of the read operation. The processor will control the setting of these signals by placing a bit in modifier position 1, 3, and 4 to activate Device Control Line 1, 3 and 4 respectively.

Device Control Line 1 Out. This signal will be up when modifier bit 1 of a Read command is set to a "one".

Device Control Line 3 Out. This signal will be up when modifier bit 3 of a Read command is set to a "one".

Device Control Line 4 Out. This signal will be up when modifier bit 4 of a Read command is set to a "one".

EOM In. A signal level on this line is initiated by the device and presented to the adapter after the transfer of the last byte of the message has been effected, i.e., the I/O Request and adapter response signals transferring the last byte of the message has been brought inactive.

The signal on this line should be presented and static when the I/O Request signal is detected by the adapter.

Electrical Characteristic

The signal line voltage of +3.7 volts will be used for the active state (one bit) and ground for the inactive (zero bit) state.

Timing

The timing chart for the general purpose input adapter is shown in Figure 5-14.

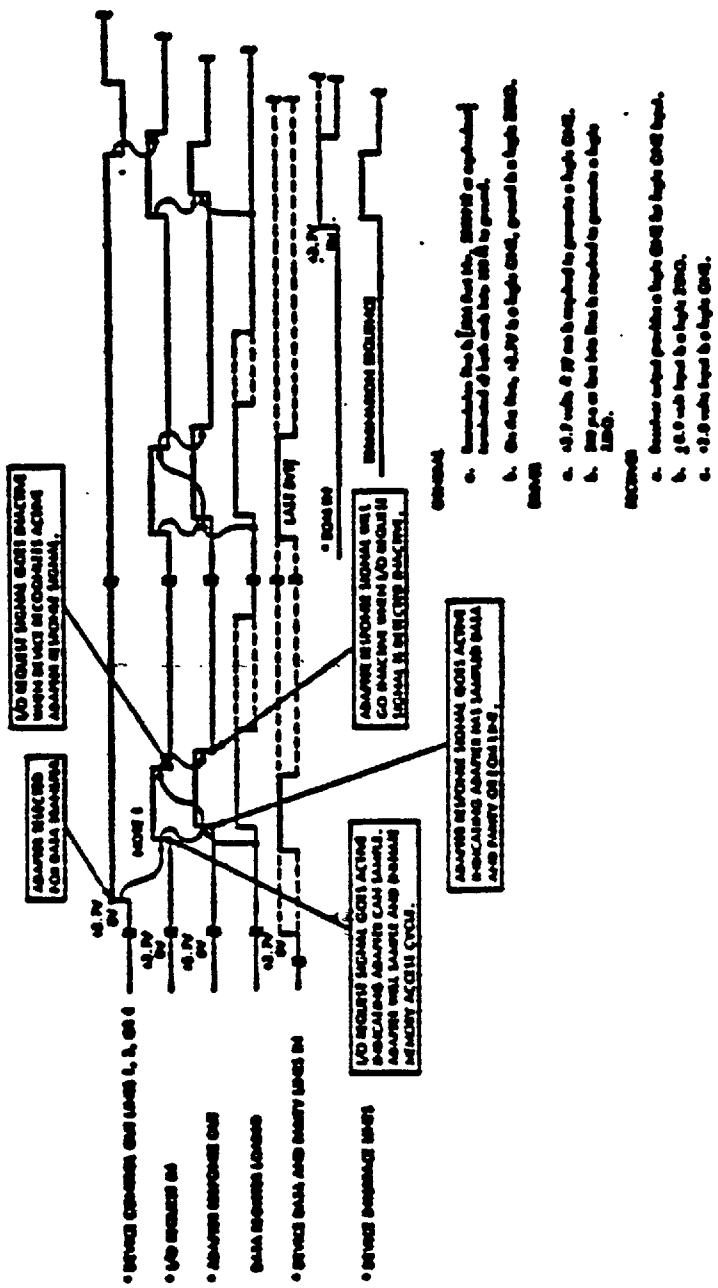

Figure 5-18. General Purpose Input Adapter Interface Timing Chart

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NOTES

GENERAL PURPOSE INPUT ADAPTER INTERFACE TIMING CHART

Note 1: Devices that read and respond to Device Control Out Lines should raise I/O Request In only after the detection of an active Device Control Out Line. Devices that do not use Device Control Out Lines may raise I/O Request In prior to the detection of an active Device Control Out Line.

Note 2: Minimum time between the fall of one I/O Request and the rise of another I/O Request is ≥2 microseconds.

Note 3: Minimum time between successive input bytes is 25 microseconds. This minimum time may be exceeded and is a function of the number of cycles taken by adapters with a higher priority and other 9020 System activity.

Note 4: The rise time measured from the 10 to 90% points of the input of the receiver at the end of 300 feet of IBM Part No. 5353912 (see Appendix B) coaxial transmission line is ≤200 nanoseconds. This time applies to circuit receivers at both the adapter end and device end of the transmission line.

Note 5: The fall time measured from the 10 to 90% points at the input of the receiver at the end of 300 feet of IBM Part No. 5353912 (see Appendix B) coax transmission line is ≤800 nanoseconds. This time applies to circuit receivers at both the adapter end and device end of the transmission line.

Note 6: Minimum time between end of one read operation and the initiation of another read operation at the device level as evidenced by the fall and rise of Device Control Out lines 1, 3, or 4 is a function of the program and other 9020 System activity.

Note 7: The active to inactive transition of the adapter response signal could occur before the associated I/O Request signal went inactive if the channel recognized the termination sequence before the device brought the I/O Request signal inactive.

Note 8: If output signals appear on more than one Device Control Out line, then a maximum skew in the output signals of 0.1 microsecond can occur at the PAM connector. Differences in cable and receiver characteristics will increase signal skew between lines. This note is not applicable under present contemplated use which is to activate only one device control line at a time.

Device - Adapter Interface Circuit Specification

General

The transmission line must be terminated at each end in 100 ohms ±5 ohms to ground. The connection between the end of the transmission line and the 100 ohm line terminator shall not exceed 6 inches. The device circuits and adapter circuits may be placed anywhere along the transmission line; however, the connection between the device circuit or adapter circuit signal to the transmission line shall not exceed 6 inches. The length of the transmission line between the device circuit output and the device input-output connector (external cable connector) point is

limited by the DC resistance of the transmission line and shall not exceed two ohms. The receiver and driver design requirements take into account the extraneous voltages on the transmission line due to coupled noise (±0.5 volt maximum) and attenuated ground shift between device and adapter circuit ground. The unattenuated ground shift between device and adapter circuit ground shall not exceed ±0.5 volt.

Unattenuated ground shift is defined as that voltage which exists between the device termination ground and the adapter termination ground.

Attenuated ground shift is that portion of the unattenuated ground shift which appears across the termination resistor. It is the ratio of the adapter resistance (100 ohms) to the total circuit resistance (100 ohms at the adapter plus 100 ohms at the device plus the cable resistance), times the unattenuated ground shift.

Driver Requirements

With respect to the transmission line, the driver provides a logic zero by supplying less than 200 ua of current into or out of the line; it provides a logic one by supplying a minimum of +3.7 volts to the line. In order to drive the line load, 77 ma is required at +3.7 volts. The maximum voltage the driver may present to the line is established by the receiver's maximum allowable positive input voltage of +6.24 volts.

Receiver Requirements

The receiver output shall be interpreted as presenting: a logic one when the receiver input is a logic one and a logic zero when the receiver input is a logic zero, ground, or open. The open input is defined as retaining the 100 ohm line termination to ground at the input to the receiver.

The equivalent circuit of the receiver presented to the transmission line shall be 1000 ohms or greater referenced to an internal bias voltage anywhere between ±1.0 volt. The receiver must accept any voltage between ±0.9 volt as a logic zero input from the transmission line. For the logic one input, the receiver must not require an input level from the transmission line more positive than +2.0 volts, nor be damaged by an input level of +6.24 volts.

Fault Condition Requirements

1. The signal lines may be grounded with no damage to either drivers or receivers.

2. Loss of power at either end does not cause any damage.

3. Line operation is unaffected where power is switched off in any receiver or driver.

APPENDIX XVI

GPI Adapter Device Interface Pin Assignments

I/O Connector Pin	Cable-Line Name
B02	Data Bit Pos P
B07	Data Bit Pos 0
B03	Data Bit Pos 1
B04	Data Bit Pos 2
B04	Data Bit Pos 3
B05	Data Bit Pos 4
B05	Data Bit Pos 5
B06	Data Bit Pos 6
B10	Data Bit Pos 7
B09	I/O Request
D09	Adapter Response
B08	BCM
D10	Device Control Line 4
B13	Device Control Line 3
B12	Device Control Line 1
B07, B13 D02, D08	Shields

For signal and shield terminations, refer to Appendix B.

APPENDIX XVII

GENERAL PURPOSE OUTPUT ADAPTER

General Characteristics

This adapter will present a device interface to enable various government furnished devices to receive and control data transferred from the processor.

The GPO adapter will present data in an 8-bit plus parity (even or odd) format on a demand/response basis where the device will initiate the byte transfer signal. Unused data positions are zero and appear in the high order bits of the data byte starting with bit 0. Maximum data rate is determined by the 9020 system.

Peripheral Adapter Module 163

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SPECIFICATION CHANGE NOTICE

(SEE MIL-STD-490 FOR INSTRUCTIONS)

1. ORIGINATOR NAME AND ADDRESS	2.	3. CODE IDENT.	4. SPEC. NO.
Richard Simon AAP-310	☐ PROPOSED ☒ APPROVED		FAA-E-2711A
		5. CODE IDENT.	6. SCN NO. 001

DATE PREPARED

7. SYSTEM DESIGNATION	8. RELATED ECP NO. N9868	9. CONTRACT NO.	10. CONTRACTUAL ACTIVITY
11. CONFIGURATION ITEM NOMENCLATURE		12. EFFECTIVITY	

THIS NOTICE INFORMS RECIPIENTS THAT THE SPECIFICATION IDENTIFIED BY THE NUMBER (AND REVISION LETTER) SHOWN IN BLOCK 4 HAS BEEN CHANGED. THE PAGES CHANGED BY THIS SCN BEING THOSE FURNISHED HEREWITH AND CARRYING THE SAME DATE AS THIS SCN. THE PAGES OF THE PAGE NUMBERS AND DATES LISTED BELOW IN THE SUMMARY OF CHANGED PAGES. COMBINED WITH NON-LISTED PAGES OF THE ORIGINAL ISSUE OF THE REVISION SHOWN IN BLOCK 4, CONSTITUTE THE CURRENT VERSION OF THIS SPECIFICATION.

13. SCN NO.	14. PAGES CHANGED (INDICATE DELETIONS)	* 15. S	* A	DATE
001	Attach Appendix XVIII to Specification FAA-E-2711A			

16. TECHNICAL CONCURRENCE	DATE

FORM DD 1 DEC 68 1696

* "S" indicates superseded earlier page. "A" indicates added page

APPENDIX XVII

General Description

Interfaces

The GPO adapter provides for communication between PAM common and the output device. The GPO communicates with the PAM common over the adapter interface, and with the output device over the device interface.

Device Interface. The device interface lines between the GPO adapter and the device are listed below and described later. There are 18 lines:

8	Data Out Lines
1	Parity Out Line
5	Device Status In Lines
1	I/O Request In Line
1	Adapter Response Out Line
1	Adapter Selected Out Line
1	Adapter EOM Out Line

Commands

General. The GPO adapter will decode commands from the channel and indicate the acceptance or rejection of the command to the channel during a select cycle.

The valid commands for the GPO adapter are as follows:

Command	Code							
	0	1	2	3	4	5	6	7
Test I/O	0	0	0	0	0	0	0	0
Control No-Op	0	0	0	0	0	0	1	1
Sense	0	0	0	0	0	1	0	0
Write	1	0	0	0	0	0	0	1
Test Write Mode	M	0	1	0	0	0	0	1
M Modifier bit may be 0 or 1.								

Any other codes with correct parity will set sense bit 0, Command Reject, and present the unit check bit in the status byte in response to the command.

Test I/O (0000 0000). If the Test I/O command is accepted by the GPO adapter and no outstanding status conditions exist, a zero status byte is returned to the channel during the select cycle. If status information is pending, all status bits present are transmitted to the channel during the select cycle.

Control No-Op (0000 0011). The Control No-Op command is treated as an immediate type command. It performs no operation, and channel end and device end are transmitted together during the initial selection cycle.

Sense (0000 0100). Once the GPO adapter has accepted a Sense command, it will initiate a service request to the channel through PAM Common.

When the adapter is serviced, it will gate the contents of its sense register, with correct parity, to the channel. When the sense byte is accepted by the channel, the adapter will initiate a termination sequence.

Write (1000 0001). Once the GPO adapter has accepted a Write command, it will initiate a service request to the channel via PAM Common to transfer the first data byte into the adapter data register for transmission to the device. When the device has requested and accepted this data byte, another service request is initiated and the sequence is repeated until termination is indicated.

After the last byte of the message has been set into the adapter data register (in other words, the byte count equals zero at the channel) and the device has accepted the last byte, the ensuing service request from the adapter will result in a termination indication from the channel. The adapter will then initiate a termination sequence and present Channel End and Device End Status.

The modifier bit zero in this command code is set to a "one" to condition a second gate for each output signal from the adapter to the device. The purpose is to prevent erroneous signals from being transmitted to the device in the event of component failures.

Test Write Mode (0010 0001) (1010 0001). Once the GPO adapter has accepted a Test Write Mode command, it will degate the device interface and allow the adapter to monitor and initiate signals on the test lines from/to the Test and Monitor adapter.

Status Information

General. The status byte is transmitted to the channel in the following situations:

1. During initial selection.

2. At the termination of any adapter command.

3. When permitted to present queued status.

Status Byte Format

Bit	Designation
P	Parity
0	Not Used
1	Not Used
2	Not Used
3	Not Used
4	Channel End
5	Device End
6	Unit Check
7	Not Used

Status Bit 4 and 5 -- Channel End and Device End. These bits are always presented together by the GPO adapter. Once set, they will block any further transmission of data or sense information and will present status to the channel when allowed to do so. They are set under the following conditions.

1. During the initial selection phase of a Control No-Op.

2. At the termination of [illegible] command [illegible] will cause operation to [illegible]

3. At the termination of a Write or Test Write Mode command.

4. Upon detection of a Halt I/O condition.

The Channel End and Device End condition is reset by the acceptance of the status byte by the channel.

Status Bit 6 - Unit Check. Unit Check status is indicated during the initial selection cycle or at Channel End and Device End time. To enable the processor to obtain a more detailed picture of the cause of that Unit Check condition, a sense command should be initiated.

Unit Check status is set when the following conditions are detected.

1. During an initial selection cycle —

   Command Reject
   Bus Out Check

2. At Channel End and Device End time (write termination sequence)

   Bus Out Check
   Data Check
   Device Inoperative Indication
   Device Status Line 3 Indication
   Device Status Line 5 Indication
   Device Status Line 6 Indication
   Device Status Line 7 Indication

Sense Information

General. A Sense command should be initiated upon detecting a unit check condition in the status byte. The sense register positions are reset by the acceptance of the next valid Write or Test Mode Command. With the exception of bit 2, Bus Out Check, the sense register is also reset when Bus Out Check occurs during Command Out. With the exception of the Command Reject bit, the sense register is also reset when a Command Reject occurs.

Bit	Designation
P	Parity
0	Command Reject
1	Device Inoperative
2	Bus Out Check
3	Device Status Line 3
4	Data Check
5	Device Status Line 5
6	Device Status Line 6
7	Device Status Line 7

Sense Bit 0 - Command Reject. Command Reject will be set during the initial selection cycle of a command if the bit configuration with correct parity is other than those listed in the "Commands" section of the GPO description (above). All other sense register positions are reset.

Sense Bit 1 - Device Inoperative. Device sense bit 1, will be set on two occasions:

1. During a Test I/O select sequence if the Device Inoperative Line is at a ground level.

2. At any time after the adapter has accepted a valid write command, has raised the adapter selected out line and is not in the act of presenting status information to or obtaining data from the processor, and the Device Inoperative Line is at ground level.

In event the Device Inoperative Line between the device and the adapter is broken, a bit is set into Sense Register position 1 on the two occasions listed above. Whenever this line is sensed and found to be active (open or ground level) the adapter will also sense Device Status Lines 3, 5, 6, and 7. Upon detection of a "Device Inoperative" condition, the operation will be terminated and Unit Check presented with Channel End and Device End status.

Sense Bit 2 - Bus Out Check. Bus Out Check will be set at any time a Bus Out Check signal is received over the adapter interface. A Bus Out Check signal will occur if PAM common detects a parity error on the data Bus Out (from the IOCE to PAM common) and the Command Out or Service tags are active.

A Bus Out Check detected during a select sequence will set a unit check bit in the status byte and the command will be ignored. The sense register, with the exception of Bus Out Check, will be reset at this time.

A Bus Out Check detected during a Write operation (data transfer) will cause the Write operation to be terminated and the Unit Check bit set along with Channel and Device end in the ensuing status byte. The data byte in error will not be transmitted, and no further data bytes will be transferred from the channel during that particular write operation.

Sense Bit 3 - Device Status Line 3. Device Sense Bit 3 will be set if the Device Status Line 3 is active during a Write operation in the interval between the I/O Request signal going inactive and the adapter response signal going inactive, or at any time that the Device Status Line 3 is active when Device Inoperative is active. The Unit Check indication is presented along with Channel End and Device End in the ensuing status byte. An active Device Status Line 3 signal detected by the GPO adapter will cause the Write operation to be terminated.

Programming Note. The meaning assigned to Device Status Line 3 is a function of the device attached to the GPO adapter. This assignment could indicate parity errors detected at the device.

Sense Bit 4 - Data Check. Data Check will be set at any time a data byte with incorrect parity is set into the GPO adapter data register. A Data Check will cause the Write operation to be terminated and the Unit Check indication will occur along with Channel End and Device End in the ensuing status byte. The data byte in error will not be transmitted, and no further data bytes will be transferred from the channel during that particular write operation.

Sense Bit 5 - Device Status Line 5. Device Sense Bit 5 will be set if the Device Status Line 5 is active during a Write operation in the interval between the I/O Request signal going inactive and the adapter response signal going inactive or, at any time that the Device Status Line 5 is active when Device Inoperative is active. The Unit Check indication is presented along with Channel End and Device End in the ensuing status byte.

An active Device Status Line 5 detected by the GPO adapter will cause the write operation to be terminated. [illegible] status lines.

Programming Note. The meaning assigned to Device Status Line 5 is a function of the device attached to the GPO adapter.

Sense Bit 6 - Device Status Line 6. Device Sense Bit 6 will be set if the Device Status Line 6 is active during a write operation in the interval between the I/O Request signal going inactive and the adapter response signal going inactive, or at any time that the Device Status Line 6 is active when Device Inoperative is active. The Unit Check indication is presented along with Channel End and Device End in the ensuing status byte.

An active Device Status Line 6 detected by the GPO adapter will cause the write operation to be terminated.

Programming Note. The meaning assigned to Device Status Line 6 is a function of the device attached to the GPO adapter.

Sense Bit 7 - Device Status Line 7. Device Sense Bit 7 will be set if the Device Status Line 7 is active during a write operation in the interval between the I/O Request signal going inactive and the adapter response signal going inactive, or at any time that the Device Status Line 7 is active when Device Inoperative is active. The Unit Check indication is present along with Channel End and Device End in the ensuing status byte.

An optional termination of the write operation is provided if an active device status line 7 is detected by the GPO adapter. This option is manually selectable in the field.

If the GPO adapter is "jumper wired" not to terminate the write operation upon detection of an active Device Status Line 7, sense register position 7 is set. However, Unit Check status is not presented to the channel until status is initiated from another source (Channel End and Device End or the detection of active device status lines 1, 3, 5, or 6).

If the GPO Adapter is "jumper wired" to terminate the write operation, detection of an active Device Status Line 7 will cause write operation to be terminated and Sense Bit 7 to be set.

Programming Note. The meaning assigned to Device Status Line 7 is a function of the device attached to the GPO adapter.

Priority

The priority position is address dependent, i.e., the lower the address assigned the higher the priority. To upgrade or downgrade the priority of a particular adapter, the address of the adapter must be changed accordingly.

General Purpose Device Output Interface Description

General. The General Purpose Output interface provides a uniform method of attaching output devices to the General Purpose Output adapter. It consists of a set of lines which are used to transmit information to the output device. Each interface can accommodate one output device.

APPENDIX XVII

Signal Lines. The signal lines for the General Purpose Output interface are as follows:

Data Lines	Initiated By
Data Out Bit Pos P	Adapter
Data Out Bit Pos 0	Adapter
Data Out Bit Pos 1	Adapter
Data Out Bit Pos 2	Adapter
Data Out Bit Pos 3	Adapter
Data Out Bit Pos 4	Adapter
Data Out Bit Pos 5	Adapter
Data Out Bit Pos 6	Adapter
Data Out Bit Pos 7	Adapter

Control Lines	Initiated By
I/O Request In	Device
Adapter Response Out	Adapter
Device Inoperative In	Device
Device Status Line 3 In	Device
Device Status Line 5 In	Device
Device Status Line 6 In	Device
Device Status Line 7 In	Device
Adapter Selected Out	Adapter
Adapter End of Message Out	Adapter

Signal Line Description

Data Out Line (Bits 0-7). The signals on these parallel lines will be presented by the adapter to the device and will be static when the adapter response signal is detected by the device.

The adapter is capable of presenting 8 data out lines to the device; however, the device need only monitor the number of lines applicable to the device.

Parity Line. The adapter originates a signal on this line to establish odd (or even) parity to the associated data lines. This signal level will be presented to the output device and will be static when the adapter response signal is detected by the device. The device need not monitor this line if not applicable to the device. The odd (or even) assignment is "jumper wired" and is easily changeable in the field.

I/O Request In. The signal level on this line is initiated by the output device. When the I/O Request signal is detected by the adapter, and the adapter has a data byte or EOM Out signal to transfer to the device, the adapter will initiate an adapter response signal to the device. When the I/O Request signal goes inactive, the adapter will initiate the transfer of the next data byte from the processor to the adapter data register. By controlling the frequency of the signals on the I/O Request line, the device sets the data transfer rate within a system limitation. The device must assure that signals on device status lines 3, 5, 6, or 7 are static for sampling when the fall of I/O Request is detected by the adapter.

Adapter Response Out. An active signal on this line is initiated by the adapter when the adapter has a data byte or EOM Out to transfer to the device and the I/O Request signal is active. The adapter response signal will go inactive after the device causes the I/O Request signal to go inactive and the adapter has read the device status lines.

APPENDIX XVII

Device Inoperative. See "Sense Bit 1" - Device Inoperative.

Device Status Lines 3, 5, 6, and 7. These lines are monitored by the adapter whenever the Device Inoperative Line is active (ground level or open) or, in the absence of an active Device Inoperative signal, between the fall of I/O Request In and the fall of Adapter Response Out, during a Write operation. Upon detection of a signal(s) on lines 3, 5, and 6, the operation is terminated. A signal on Device Status Line 7 will not terminate the operation, but can be optionally changed so as to terminate the operation. Device shall reset Device Status Lines after adapter signals termination by dropping Adapter Selected Out. This will not reset sense register bits that have been set by Device Status Lines.

Adapter Selected Out. A signal on this line is initiated by the adapter and is active whenever the adapter is selected for message transfer (write mode). This signal, detected by the device, indicates that the processor has a message to transmit. Under normal conditions this signal is brought inactive during the termination sequence. If the adapter selected signal is brought inactive without the EOM signal having been presented to the device, the device is able to determine that the adapter has been deselected (write operation terminated) by some abnormal condition. There are several abnormal conditions causing the write operation to be terminated: Bus Out Check, Data Check, Device Inoperative, or an active Device Status In Line 3, 5, 6, or 7 (optional) detected by the adapter, a Halt I/O condition initiated by the program, a selective reset issued by the channel, or a system reset. This abnormal condition detected by the device could be used to enable the device to reset and set up for a retransmission. If the EOM option is exercised; i.e., not used by the device, the device would only be able to recognize that the write operation was terminated; the device may not be able to associate the fall of adapter selected with a normal or abnormal termination.

Adapter End of Message Out. The use of the adapter EOM signal by the device is optional. This option is made possible by a "jumper wire" and is easily changeable in the field.

If this signal is used by the device, the adapter response signal, resulting from any active I/O Request from the device, is used by the device to sample the adapter EOM signal (the data lines are not valid when the active adapter EOM signal is sampled). The fall of the I/O Request In that transferred the EOM signal to the device will cause the adapter to initiate the termination of the write operation.

If this signal is not used by the device, the fall of the I/O Request In signal that transferred the last byte of the message will cause the adapter to initiate the termination of the write operation.

Timing. The timing chart for the General Purpose Output Adapter is shown in Figure 6-15.

NOTES

GENERAL PURPOSE OUTPUT ADAPTER INTERFACE TIMING CHART

Note 1. - Minimum inactive time of I/O Request between two successive data transfers is ≥ 2 usec.

Note 2. Time between rise of Adapter Selected Out (or Fall of I/O Request) until adapter data register is loaded (reloaded) is a function of the number of cycles taken by adapters with a higher priority and of other CCC activity.